ENG.20070910.0021

Supplier Document Status Stamp

BSC	A. Records Designator: ☐ QA: QA ☒ QA: NA B. LSN Relevancy: ☐ LSN Relevant ☒ Not LSN Relevant C. Privileged or Copyright Protected: ☐ Yes ________ ☒ No D. Procurement Document No. NN-HC4-00197 E. BSC Standard Document No. V0-CY05-NHC4-00197-00023-001-003

F. SUPPLIER DOCUMENT STATUS

1. ☒ WORK MAY PROCEED.
2. ☐ REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO RESOLUTION OF INDICATED COMMENTS.
3. ☐ REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
4. ☐ REVIEW NOT REQUIRED. WORK MAY PROCEED.
5. ☐ FOR INFORMATION ONLY.

PERMISSION TO PROCEED DOES NOT CONSTITUTE ACCEPTANCE OR APPROVAL OF DESIGN DETAILS, CALCULATIONS, ANALYSES, TEST METHODS, OR MATERIALS DEVELOPED OR SELECTED BY THE SUPPLIER AND DOES NOT RELIEVE SUPPLIER FROM FULL COMPLIANCE WITH CONTRACTUAL OBLIGATIONS.

G. REVIEW COPY												
	NVM	NE										
	bg	KAM										

H. Area Code NA System Code NA Baseline Level NA

I. DOCUMENT CATEGORY NA
(Attach 3, Attach 4, or SSRS Form as applicable)

J. William Garfield Wm. I. Garfield 9/5/07
RESPONSIBLE ENGINEER/ANALYST (Printed Name and Signature) DATE

Title: Ballast Quarry Mina Rail Corridor

Supplier Document #: 21-1-20102-225

Supplier Rev.: 1

Supplier Date: 07/26/07

Reference #: NVT-CD-00183

NVM Nevada Transportation Manager Bill Garfield
NE Nevada Engineering Kathy Mrotek

BSC	# Supplier Document Distribution *Complete only applicable items.*	QA: N/A Page 1 of 1

1. Supplier/Subcontractor Name:		Purchase Order/Subcontract No. and Title:
Shannon & Wilson		NN-HC4-00197 /Ballast Quarry Report
2. BSC Submittal No.:	Revision:	Title:
V0-CY05-NHC4-00197-00023-001	003	Ballast Quarry Report Mina Rail Corridor

Responsible Individual:	Wm. Garfield	WG	423	09/04/07	09/13/07
	Name (Print)	Initials	Mailstop	Date	Due Date

DISTRIBUTION

Discipline/Organizations	Abbrev.*	3. Name	Mailstop	4. For Review	5. After Acceptance
				☐	☐ E ☐ H
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6. Document transmitted contains OUO information? ☐ Yes ☒ No

*** Use these abbreviations on the Supplier Document Status stamp to indicate reviewers.**

BSC

Transportation Data Pedigree Form

Complete only applicable items.

QA: N/A

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor, Rev. 1 (Submittal No. 7.32)	26 Jul 2007	07-00027

Section I. Submittal Information (includes above information)

Submittal Description and Revision Summary for Entire Submittal:

This report documents information collected from a literature review and field reconnaissance performed for the purpose of identifying potential sources of railroad ballast along the proposed Mina alignment of the Nevada Rail Line for the Yucca Mountain Project.

Revision Summary:
Rev 0, 13 Mar 07: Original submittal
Rev 1, 26 Jul 07: Revised Table 1 and Appendix E to address copyrighted material

Special Instructions:

Section II. Data File Information (Add lines below if needed for additional files. Indicate "Last item" or "End of list" after last line used.)

Filename	Rev.	File Size	Description (File description and revision summary for file)	Application and Version/ Add-in or Extension and Version
_Cover 26 July 07.ppt	1	698 KB	Ballast Quarry Report Front Cover	MS Power Point 2003 SP2
Jacobs LOGO.jpg	1	29 KB	Ballast Quarry Report Cover Image	Corel PHOTO-PAINT 8.0 Image
_Spines 2007.dwg	1	431 KB	Ballast Quarry Report Spine Cover	AutoCAD 2007
Spine 1.5.jpg	1	417 KB	Ballast Quarry Report Spine Image	Corel PHOTO-PAINT 8.0 Image
CD Background 2007.jpg	1	1,280 KB	Ballast Quarry Report CD Image	Corel PHOTO-PAINT 8.0 Image
BSC Logo.jpg	1	22 KB	Ballast Quarry Report CD Image	Corel PHOTO-PAINT 8.0 Image
_CD Labels 2007.dwg	1	619 KB	Ballast Quarry Report CD Label	AutoCAD 2007
SW-ColourMidWidth 100.ctb	1	5 KB	Ballast Quarry Report CD Label	AutoCAD 2007
21-1-20102-225-Rev1X.doc	1	283 KB	Ballast Quarry Report Title Sheet	MS Word 2003 SP2
21-1-20102-225-Change-History-M-Quar.doc	1	34 KB	Ballast Quarry Report Change History Sheet	MS Word 2003 SP2
21-1-20102-225-Rev1.doc	1	2,158 KB	Ballast Quarry Report Text, Appendix Title Sheets and Text, Subappendix Title Sheets and Text and Appendix B Biosketches	MS Word 2003 SP2
21-1-20102-225-T1-Rev1.xls	1	23 KB	Ballast Quarry Report Table 1, Summary of Laboratory Test Results	MS Excel 2003 SP2
21-1-20102-225-T2-Rev1.xls	1	17 KB	Ballast Quarry Report Table 2, Schmidt Hammer Results	MS Excel 2003 SP2
21-1-20102-225-T3-Rev1.xls	1	19 KB	Ballast Quarry Report Table 3, Quarry Site Rating Table	MS Excel 2003 SP2

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor, Rev. 1 (Submittal No. 7.32)	26 Jul 2007	07-00027

21-1-20102-225_Fig-6_Malpais-Mesa-South_Ballast-Quarry-Conceptual-Layout_T.jpg	1	239 KB	Ballast Quarry Report Figure 6, Malpais Mesa South Ballast Quarry Conceptual Layout, Image	Corel PHOTO-PAINT 8.0 Image
21-1-20102-225_Fig-7_Malpais-Mesa-CRC-And-Malpias Mesa-South-MRC-Quarry-Locations_T.jpg	1	304 KB	Ballast Quarry Report Figure 7, Malpais Mesa (CRC) and Malpais Mesa South (MRC) Quarry Locations, Image	Corel PHOTO-PAINT 8.0 Image
21-1-20102-225_Fig-8_North-Clayton_Ballast-Quarry-Conceptual-Layout_T.jpg	1	245 KB	Ballast Quarry Report Ballast Quarry Report Figure 8, North Clayton Ballast Quarry Conceptual Layout, Image	Corel PHOTO-PAINT 8.0 Image
21-1-20102-225_Fig-9_Gabbs-Range_Ballast-Quarry-Conceptual-Layout_T.jpg	1	229 KB	Ballast Quarry Report Figure 9, Gabbs Range Ballast Quarry Conceptual Layout, Image	Corel PHOTO-PAINT 8.0 Image
21-1-20102-225_Fig-10_Garfield-Hills_Ballast-Quarry-Conceptual-Layout_T.jpg	1	222 KB	Ballast Quarry Report Figure 10, Garfield Hills Ballast Quarry Conceptual Layout, Image	Corel PHOTO-PAINT 8.0 Image
21-1-20102-225_Fig-11_Weber-Dam_Ballast-Quarry-Conceptual-Layout_T.jpg	1	252 KB	Ballast Quarry Report Figure 11, Weber Dam Ballast Quarry Conceptual Layout, Image	Corel PHOTO-PAINT 8.0 Image
Black-Tabs-Page-1.doc	1	56 KB	Ballast Quarry Report Subappendix Tabs	MS Word 2003 SP2
Black-Tabs-Page-2.doc	1	56 KB	Ballast Quarry Report Subappendix Tabs	MS Word 2003 SP2
Field Evaluation Malpais Mesa South-Rev1.doc	1	4,647 KB	Ballast Quarry Report Sub Appendix A-1, Quarry Field Evaluation Checklist, Malpais Mesa South	MS Word 2003 SP2
Field Evaluation North Clayton Rev1.doc	1	3,665 KB	Ballast Quarry Report Sub Appendix A-2, Quarry Field Evaluation Checklist, North Clayton	MS Word 2003 SP2

BSC

Transportation Data Pedigree Form

Complete only applicable items.

QA: N/A

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor, Rev. 1 (Submittal No. 7.32)	26 Jul 2007	07-00027

Field Evaluation Gabbs Range Rev1.doc	1	12,362 KB	Ballast Quarry Report Sub Appendix A-3, Quarry Field Evaluation Checklist, Gabbs Range	MS Word 2003 SP2
Field Evaluation Garfield Hills Rev1.doc	1	6,833 KB	Ballast Quarry Report Sub Appendix A-4, Quarry Field Evaluation Checklist, Garfield Hills	MS Word 2003 SP2
Field Evaluation Weber Dam Quarry Rev1.doc	1	10,938 KB	Ballast Quarry Report Sub Appendix A-5, Quarry Field Evaluation Checklist, Weber Dam	MS Word 2003 SP2
ROCK FIELD REFERENCE, rev-jul07.pdf	1	624 KB	Ballast Quarry Report Rock Field Reference	Adobe Acrobat 7.0
Mina_S&W_BQR .mdb	1	1,724 KB	ESRI 9.2 Personal Geodatabase containing the following Shannon & Wilson, Inc. native files pertaining to studies related to the Ballast Quarry Report dated 07/26/07.	ESRI Geodatabase
MinaBallast,R1,26jul07.pdf	1	79,688 KB	Adobe Acrobat report	Adobe Acrobat 7.0
			---------------------Last Item---------------------	

Section III. Metadata

☒ **GIS Metadata** All GIS data is preferred in ArcGIS9.1 UTM, NAD1983, Zone11, Feet.	Projection: UTM
	Datum: NAD 83
	Zone: 11 N
	Units: Feet
☐ **CAD Metadata** CAD drawings are preferred in **Bentley MicroStation V8 and/or InRoads** and should adhere to established **CAD standards.**	Level descriptions:
	Scale:
	Units of Measurement:
	Horizontal and Vertical Datum:

Section IV. Data Screening (Completed by BSC personnel)

Acceptable for Review?	Screener Name:	Signature:	Date:
☒ Yes* ☐ No	Cathy Stettler	Cathy Stettler	8/22/07

*If "Yes", Data Storage Location: nvtdata\SW\Phase1\07-00027 Ballast Quarry Report Mina Rev 01 07-26-07

Comments: *(Justification for returning submittal is **required**; other comments are optional.)*

Section V. STR/STR Support Disposition of Submittal

Process for Review?	** If "No", date returned:	Comments:
☐ Yes ☐ No**		

STR/STR Support Name:	Signature:	Date:
~~Kathy Mrotek~~ William Garfield	Wm. l. Garfield	8/23/07

KAM 8/23/07

Data Definitions for Ballast Quarry Report GIS Features

Feature Class: access_quarry_sw_mina

Description: Line features pertaining to quarry sites. Features include existing roads, proposed roads, and quarry conveyor belts.

Purpose: This feature class is used for identifying significant access routes associated with quarry sites.

Revision History: No Changes
Number of records: 31

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polyline.
TYPE	Text	Indicates purpose of the feature.
STATUS	Text	Indicates condition and suggested action of feature.
SHAPE_Length	Double	Length of feature in feet generated by software.

Feature Class: Ballast_Source_Study_areas_sw_mina

Description: This polygon feature class represents investigated areas of ballast sources. This area was designated by S&W and BSC.

Purpose: Area of study for investigation to identify potential ballast sources.

Revision History:
No changes.

Number of records: 2

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: Buffer_of_mina022307_SW_10

Description: This polygon feature class represents a 10 mile buffer of the alignment file "mina022307.shp" provided by BSC.

Purpose: To identify limits of project area.

Revision History:
No changes.

Number of records: 1

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
BufferDist	Double	Distance, in miles, of buffer based on mina022307.shp.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: facilities_quarry_sw_mina

Description: This polygon feature class represents Shannon & Wilson, Inc. selected areas for potential facilities associated with quarry sites within the Mina Corridor.

Purpose: To identify quarry site locations and associated facilities as part of the conceptual layout of potential quarry sites.

Revision History:
No Changes.

Number of records: 26

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
Site_Type	Text	Purpose or potential use of feature.
Study_Area	Text	Quarry site location of feature.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: Geology_ballast_sw_mina

Description: This polygon feature class represents geologic units compiled from various county source maps (See Plate 1) at a 250k scale.

Purpose: To identify geologic units associated with the investigation of suitable ballast source areas.

Revision History:
No Changes.

Number of records: 215

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
TYPE	Text	Geologic unit description.
County	Text	County map that the geologic unit originates from.
SITENAME	Text	Related quarry site.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: title_block_250k_sw_mina

Description: This polygon feature class is for drafting presentation purposes only. This feature is associated with the production of Shannon & Wilson, Inc. plates only. It contains no data associated with study of this report.

Purpose: For presentation purposes only. The feature allows areas to be masked at a 250k scale to clearly represent the title block area.

Revision History:
No Changes.

Number of records: 1

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Polygon.
SHAPE_Length	Double	Length of feature in feet generated by software.
SHAPE_Area	Double	Area of feature in feet generated by software.

Feature Class: waypoints_sw_mina

Description: This point feature class represents areas of interest collected by Shannon & Wilson, Inc. in the field while individual teams investigated the Mina Corridor.

Purpose: To identify areas visited in various team field reconnaissance trips.

Revision History:
No Changes.

Number of records: 292

Field Name	Data Type	Description of field
OBJECTID	Object ID	Unique identifier generated by the software. This identifier will act as a primary key.
SHAPE	Geometry	Point.
WAYPOINTID	Text	Field assigned name of point feature. 'M'=Mina, 'T#'=Team and trip number, '###'=sequential number of feature per trip.
Route	Text	Route location of associated point feature based on project alignment.

BSC

Transportation Submittal Receipt Traveler

Complete only applicable items.

QA: N/A

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor Rev 1	7/26/07	07-00027

Section I. Receive the Submittal

Receiver Name: Cathy Stettler — Receipt Date: 8/22/07

DMPOC Receipt Prescreening	N/A	Yes	No
Is there a transmittal sheet?	☐	☒	☐
Does each delivered item match the transmittal (e.g., five disks, two sets of hardcopy documents)?	☐	☒	☐
Is there a **Data Pedigree** form?		☒	☐
If media is part of the submittal, does each media label match the transmittal and **Data Pedigree** form?		☒	☐

Receipt prescreening results: (Check applicable box)

☒ **All** criteria met for **all** items – **Accept submittal** for screening.

☐ **Any** criteria **not** met for **any** item –either (check applicable box)
☐ **Resolve issue and continue processing**; or
☐ **Return submittal** – Document comments; see Section III for additional actions.

DMPOC Comments:

Submittal received 8/17/07. Revised/resubmitted due to copyright permissions.

Section II. Screen the Submittal

DMPOC Screening	Yes	No
1. Hardcopy included? (If yes, route hardcopy to STR/STR Support for screening; if no, mark STR/STR Support screening section as "N/A")	☒	☐
2. **Documentation Review** – Review indicated section of **Data Pedigree** (DP) form to determine if it:		
– Includes item number, title, and revision (on every page of multi-page DP)? (Above Section I)	☒	☐
– Contains submittal description – overall data, constraints, limitations, or assumptions? (Section I)	☒	☐
– Lists all files and a description of each file? (Section II)	☒	☐
– Identifies file revisions clearly and includes revision description? (Section II)	☒	☐
– Lists application and version and any add-in or extension and version? (Section I)	☒	☐
– Contains completed metadata section? (Section I)	☒	☐
– Is appropriately marked per SY-PRO-4010?	☒	☐
3. **Media Review** – Determine file accessibility and proper content on the media:		
– Each file can be viewed with the stated application and is a good copy?	☒	☐
– **All** files match **Data Pedigree** entries? (All files on the media are listed on the DP; all files listed on the DP are contained on the media.)	☒	☐
– Is appropriately marked per SY-PRO-4010?	☒	☐

Screening results: (Check applicable box)

☒ **All** criteria met for **all** files – **Accept submittal** for engineering review.

☐ **Any** criteria **not** met for **any** item –either (check applicable box)
☐ **Resolve issue and continue processing**; or
☐ **Return submittal** – Document comments; see Section III for additional actions.

DMPOC Comments:

Initials: CJS — **Date:** 8/22/07

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor Rev 1	7/26/07	07-00027

STR/STR Support Screening	Yes	No	N/A
– Is the submittal the expected product(s) based on Statement/Scope of Work (SOW)?	☐	☐	☐
– Is each document legible and formatted correctly for that document type?	☐	☐	☐

Screening Results: (Check applicable box)

☐ **Any** criteria **not** met for **any** item – either (check applicable box)
- ☐ **Resolve issue and continue processing**; or
- ☐ **Return submittal** – Document comments; see Section III for additional actions.

☐ **All** criteria met for all files – **Accept submittal** – Complete Distribution List.

Deliver submittal to DOE and EIS contractor for "at-risk" use during engineering review?	☐	☐	

STR/STR Support Comments:

Initials: RAH 8/23/07 bg 8/23 Date:

Section III. Return Submittal

DMPOC:

- ☐ Update Data Pedigree – Check "No" in "Acceptable for Review" block. Document reason for return in "Comments" block..
- ☐ Provide copy of updated Data Pedigree to STR/STR Support.
- ☐ Ensure media are marked with SRCT number, review date, and status ("Returned").
- ☐ Segregate returned submittal to preclude use or destroy it.
- ☐ Notify affected parties of submittal status. Include date received and reason for return.

STR/STR Support:

☐	**Update SRCT database with screening results.**	**Initials:**	**Date:**
☐	Deliver documentation to Records Coordinator.		
☐	**Perform needed actions to finalize submittal return to Subcontractor.**	**Initials:**	**Date:**

Section IV. Process "Acceptable for Review" Submittal

DMPOC:

☒	Copy data files to nvtdata under appropriate subcontractor: ***nvtdata/subcontractor/phase/task/SRCT number***		
☒	Update Data Pedigree – Check "Yes" in "Acceptable for Review" block. Document any comments (optional).		
☒	Ensure media are marked with SRCT number.		
☒	Notify affected parties of submittal status.		
☒	**Update SRCT database with screening results, file location, etc.**	**Initials:** JB	**Date:** 8/22/07
☒	Deliver submittal to Records Coordinator.		

Records Coordinator:

- ☒ Post submittal to NVT eRoom.
- ☒ Post submittal to DOE eRoom? ☒ Yes ☐ No
- ☒ Make/obtain hardcopies and electronic copies of submittal and transmittal based on spreadsheet or STR/STR Support guidance.

Initials: DM Date: 8/22/07

TS Admin:

☐	Prepare transmittal letter; indicate submittal status and restrictions; obtain Manager, Transportation approval.		
☐	Scan letter; place PDF in letter file.		
☐	Create labels that contain transmittal letter number; attach labels to letter enclosures (copies prepared above).		
☐	Deliver advance copies of submittal and original transmittal to EIS Coordinator for delivery as needed.		
☐	Distribute submittal package per distribution list.		
☐	Deliver copy of submittal package to STR/STR Support.		
☐	**Update SRCT database with transmittal letter information.**	**Initials:**	**Date:**

BSC

Transportation Submittal Receipt Traveler

Complete only applicable items.

Subcontractor:	Item Number/Title/Revision:	Submittal Date:	SRCT No.:
Shannon & Wilson, Inc.	Ballast Quarry Report – Mina Rail Corridor Rev 1	7/26/07	07-00027

Records Coordinator:

Submittal goes to RPC/DC/EDC? ☒ Yes ☐ No | If Yes, date submitted: | By: (initials)

EIS Interface Coordinator: Complete only if STR/STR Support indicated advance copy delivery was needed.

☐ Deliver advance copies of submittal to DOE/EIS contractor for "at-risk" use.

☐ **Update SRCT database with delivery information.** | **Initials:** | **Date:**

STR/STR Support:

☐ Ensure submittal is routed for review in accordance with TS-DSK-1003, *Transportation Implementation of EG-PRO-3DP-G04B-00058, Supplier Engineering and Quality Verification Document.*

Section V. Post-Review Submittal Processing

STR/STR Support or Review Coordinator:

☐ **Update spreadsheet with review completion date** | **Initials:** | **Date:**

☐ **If returning submittal, document comments** – see Section III for additional actions.

Comments:

Distribution List: STR/STR Support – in left column, indicate needed Reviewers (R) and/or distribution (D) recipients and indicate the number of each type of media needed. Records Coordinator/TS Admin – check column 5 when delivered.

Addresses are on file for distribution noted below. **Provide address for any "Other" entries.**

Indicate R or D	Number of copies for each type of output: Electronic	✓GIS Data Only	Hardcopy	✓When Delivered	Organization(s) Represented/Recipient Name
					EIS Interface Coordinator (for DOE/MTS/PHE)/
					ICF, PHE, URS/
					PB, Converse/
					Shannon & Wilson/
					HNTB / NRP/
					IDT/
					Spencer B. Gross/
					Horizon Surveys/
					DOE/
					DOE/
					BSC/
					BSC/
					NVT Library/
					Records / Engineering Document Control/
					Spares/
					Transportation GIS Shop/
					Other:
					Other:

Ballast Quarry Report
Mina Rail Corridor

SRCT:
07-00027

Task 2.5a: Quarry Site Description Report
(Submittal No. 7.32)

REV. 1

Prepared by:

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

In Association With:

JACOBS

Ninyo & Moore

Prepared for:

BECHTEL SAIC COMPANY, LLC

Nevada Rail Corridor
Yucca Mountain Project
Geotechnical Analysis
NN-HC4-00197

July 26, 2007

Ballast Quarry Report
Rev. 1
Mina Rail Corridor
Yucca Mountain Project, Nevada

Subcontract No. NN-HC4-00197

26 July 2007

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

At Shannon & Wilson, our mission is to be a progressive, well-managed professional consulting firm in the fields of engineering and applied earth sciences. Our goal is to perform our services with the highest degree of professionalism with due consideration to the best interests of the public, our clients, and our employees.

Submitted To:
Bechtel SAIC Company
1180 Town Center Drive
Las Vegas, Nevada 89144

By:
Shannon & Wilson, Inc.
400 N 34th Street, Suite 100
Seattle, Washington 98103

21-1-20102-225

Prepared using MS-WORD 2003

CHANGE HISTORY

Revision Number	Date	Description of Change
00	13 March 2007	Initial Issue
01	26 July 2007	Revised Table 1 and Appendix E

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PLATE

LIST OF APPENDICES

Appendix

ACRONYMS AND ABBREVIATIONS

A	insufficient evidence for certainty rating (as relates to mineral potential)
AASHTO	American Association of State Highway and Transportation Officials
Ag	silver
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
As	arsenic
ASTM	American Society for Testing and Materials
Au	gold
AWWA	American Water Works Association
B	low certainty rating (as relates to mineral potential)
Ba	barium
BAH	Booz Allen Hamilton, Inc.
BBE	Busted Butte East
BCFG	billion cubic feet of gas
Be	beryllium
BGRR	Bullfrog Goldfield Railroad
Bi	bismuth
BLM	U.S. Bureau of Land Management
BMPs	Best Management Practices
BNSF	Burlington Northern Santa Fe Railway Company
BSC	Bechtel SAIC Company, LLC
C	moderate certainty rating (as relates to mineral potential)
CAPP	Chemical Accident Prevention Program
Cd	cadmium
CFR	Code of Federal Regulations
cm	centimeter
Co	cobalt
CPT	cone penetrometer test
Cr	chromium
CRC	Caliente Rail Corridor
CS	common segment
Cu	copper
D	high certainty rating (as relates to mineral potential)
DCM	Design Criteria Manual
DEIS	Draft Environmental Impact Statement
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EIS	Environmental Impact Statement

ACRONYMS AND ABBREVIATIONS (cont.)

EOR	engineer of record
EPA	U.S. Environmental Protection Agency
EWDP	Early Warning Drilling Program
F	fluorine
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FOB	free on board
FR	Federal Register
FRA	Federal Railroad Administration
FY	fiscal year
GCMC	Goldfield Consolidated Mines Company
G-DCM	Geotechnical Design Criteria Manual
GF3	Goldfield 3 Route
GIS	Geographic Information System
gpm	gallons per minute
GPS	global positioning system
GROA	Geologic Repository Operations Area
g/t	grams per ton
H	high mineral potential
HASP	Health and Safety Plan
Hg	mercury
HSA	hollow-stem auger
H:V	horizontal to vertical
HSU	hydrostratigraphic units
IDW	investigation-derived waste
in/sec	inches per second
ISRM	International Society of Rock Mechanics
Jacobs	Jacobs Engineering, Inc.
K	potassium
KGRA	known geothermal resource area
km	kilometer
L	low mineral potential
LR2000	Legacy Rehost 2000, a BLM land and minerals records system
LV&TRR	Las Vegas and Tonopah Railroad
M	moderate mineral potential
Ma	million years old or million years ago or million years before present
MGR	Managed Geologic Repository
MILS	mineral property location database, compiled by the U.S. Bureau of Mines
mm	millimeter
mm/sec	millimeters per second

ACRONYMS AND ABBREVIATIONS (cont.)

mm/yr	millimeters per year
MMBO	million barrels of oil
Mn	manganese
MnO	manganese oxide
Mo	molybdenum
M&O	Maintenance and Operation
mph	miles per hour
MPR	Mineral Potential Report
MRC	Mina Rail Corridor
MRDI	Mineral Resource Development, Inc.
MRDS	mineral resource dataset, compiled by U.S. Geological Survey
MS	mineral survey
MSE	mechanically stabilized earth
MVGI	Metallic Ventures Gold, Inc.
N&M	Ninyo & Moore, Inc.
Na	sodium
NAC	Nevada Administrative Code
NBMG	Nevada Bureau of Mines and Geology
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
Ni	nickel
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRL	Nevada Rail Line
NRP	Nevada Rail Partners
NTS	Nevada Test Site
NTTR	Nevada Test and Training Range (formerly Nellis Air Force Base and Testing Range)
NVT	Nevada Transportation
NWRPO	Nuclear Waste Repository Project Office
O	no mineral potential
OCRWM	Office of Civilian Radioactive Waste Management
O.D.	outside diameter
opt	ounces per ton
oz	ounce, specifically troy ounce in this report
oz/t	ounces per ton
P	phosphorous
Pb	lead
PGA	peak ground acceleration
PGR	Preliminary Geotechnical Report

ACRONYMS AND ABBREVIATIONS (cont.)

PM	particulate matter
POC	Point-of-Contact
ppb	parts per billion
ppm	parts per million
PSHA	probabilistic seismic hazard analysis
psi	pounds per square inch
PV	prefabricated vertical
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RA DEIS	Rail Alignment Draft Environmental Impact Statement
RFI	Request for Information
RFP	Request for Proposal
ROD	Record of Decision
ROE	right-of-entry
ROW	right-of-way
RQD	Rock Quality Designation
RSS	reinforced soil slopes
S&W	Shannon & Wilson, Inc.
Sb	antimony
Sc	scandium
SCS	Soil Conservation Service
Se	selenium
SFRS	steel fiber-reinforced shotcrete
SI	International System of Units
Sm	samarium
Sn	tin
SPT	Standard Penetration Test
Sr	strontium
SR	State Route
SSURGO	Soil Survey Geographic Database
T&TRR	Tonopah and Tidewater Railroad
TBM	Tunnel Boring Machine
T N	Township North
T S	Township South
Tl	thallium
tpd	tons per day
tpy	tons per year
tsf	tons per square foot
U	uranium
UPRR	Union Pacific Railroad Company

ACRONYMS AND ABBREVIATIONS (cont.)

USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USBM	U.S. Bureau of Mines
USBR	U.S. Bureau of Reclamation
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
V	vanadium
W	tungsten
WPCP	Water Pollution Control Permit
WSA	Wilderness Study Area
wt%	weight percent
YMP	Yucca Mountain Project
Zn	zinc

BALLAST QUARRY REPORT

MINA RAIL CORRIDOR
YUCCA MOUNTAIN PROJECT, NEVADA

1.0 INTRODUCTION

This report documents preliminary information collected from detailed field reconnaissance and associated laboratory testing of surface samples of rock formations that may be potential sources of ballast for the proposed Nevada Rail Line (NRL) for the Yucca Mountain Project (YMP).

1.1 Purpose and Scope

This report provides information regarding sites that may have rock suitable for processing into ballast to support the Mina Rail Corridor (MRC) Draft Environmental Impact Statement (DEIS). The scope of work included (a) training the field geologists for BSC work control and safety processes, (b) visiting potential ballast quarry sites along the proposed corridor, (c) laboratory testing of the rock obtained from outcrops at five of the sites, and (d) preparing this Ballast Quarry Report.

The purpose of the field reconnaissance was to observe exposures and outcrops of the deposits to assess if these deposits would likely constitute a suitable source, and to gather other information that would affect the selection of the sites.

No subsurface explorations were conducted as part of this study. Evaluation of rock materials for use as ballast was based on visual observation of outcrops, samples removed from rock outcrops, and the results of laboratory testing of the rock samples. The rock samples were subjected to seven tests using laboratory facilities at four companies. For use in construction, it is assumed that ballast would have to satisfy the appropriate specifications listed in the 2007 edition of the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual of Railway Engineering (AREMA, 2007).

1.2 Previous Studies

Three reports pertaining to potential ballast quarries were prepared during Phase 1 of the Caliente Rail Corridor (CRC) project. The Ballast Sourcing Cost Analysis (S&W, 2005a) presented ballast quarry criteria, permitting issues, typical quarry layout and equipment features, and estimated costs for several feasible scenarios of quarry development. The Construction Aggregate Report (S&W, 2006a) was the first step in identifying potential sources of ballast along the CRC. The Ballast Quarry Report (S&W, 2006b) presented an evaluation of 13 quarry sites along the Caliente Corridor.

For the MRC, studies for geology, construction aggregate, and ballast rock were carried out in parallel. From an original group of 28 sites that were selected from office studies of geologic maps, 15 sites were visited during the geologic reconnaissance phase of the MRC project. During a meeting with the U.S. Department of Energy (DOE) and BSC on 19 November 2006, five sites were picked for additional observation and sampling from a group of ten sites that were considered favorable after initial reconnaissance. This report is a summary of the detailed evaluation, part of the process of narrowing the number of choices for suitable ballast quarries. It is based on the 13 October 2006 (Rev. 9) alignment using U.S. Geological Survey (USGS) 1:24,000 scale base maps with 20-foot contour intervals.

1.3 Acknowledgements

This report was prepared by Shannon & Wilson, Inc. (S&W). Paul Godlewski (Project Manager) and Bill Laprade (Task Manager, Engineering Geologist) provided oversight for the task. Most of the initial field reconnaissance was performed by two S&W teams (MT1 and MT2), each comprised of an engineer and a geologist. Team MT1 consisted of Scott Pawling and Art Geldon, and team MT2 consisted of Keith Rauch and Elizabeth Karcheski. Team MT3, Bill Laprade and William "Bo" Lewis, provided supervision of the initial field reconnaissance and performed geologic mapping for a short section of the corridor. Site-specific studies and sampling of the five ballast quarry sites were accomplished Keith Rauch and Elizabeth Karcheski as team MT4. Bill Laprade was the primary author of this report, with contributions from the field personnel. Dex McCulloch, Principal-in-Charge, reviewed this report.

1.4 Authorization

This work was performed in general accordance with YMP Technical Services contract No. NN-HC4-00197, Nevada Rail Corridor Geotechnical Analysis. The Mina Corridor studies were authorized by Subcontract Modification 17, effective 15 August 2006. This document was prepared under Work Item 2.5a of the contract and this version is submittal number 7.32.

2.0 GENERAL PROJECT AND SITE DESCRIPTION

2.1 Railroad Description

The U.S. Department of Energy is studying two corridors in Nevada for possible construction of a rail line to transport spent nuclear fuel and high-level radioactive waste to a proposed repository at Yucca Mountain, Nevada. The corridors, both 0.25-mile-wide, are referred to as the Caliente and Mina corridors. DOE may eventually select one alignment within one of these corridors for the rail line. This report identifies and examines potential sources of ballast for the Mina corridor.

The Mina Rail Corridor (MRC) originates at the terminus of the Union Pacific Railroad (UPRR) at the Fort Churchill siding near Wabuska, Nevada (Plate 1). From that point the corridor extends southeastward along various alternate alignments until it intersects with the Caliente corridor either along the Caliente Alternative Alignment GF4 at station 42710+00 or along Caliente Common Segment CS4 at station 14146+54. From these intersections, the segment, common to both the Caliente corridor and the Mina corridor, would continue southeastward where it would terminate at Yucca Mountain near the southwest corner of the Nevada Test Site (NTS). Geotechnical and other studies of the segment common to both the Caliente corridor and the Mina corridor have already been completed and are contained in several reports, as referenced in subsequent sections.

The typical facilities associated with a quarry site and the assumptions governing quarry siting and costs were described in Ballast Sourcing Cost Analysis (S&W, 2005a). In summary, they are as follows:

- The quarry and appurtenant facilities located on U.S. Bureau of Land Management (BLM) land available through the BLM mineral materials leasing program.

- Quarry site at least 80 to 120 acres.
- Ballast processed at or adjacent to the quarry site.
- Quarry highwalls approximately 80 feet high with slopes of 1 Horizontal to 1 Vertical (1H:1V) overall with several benches. Overall slope 80 feet with several vertical benches to meet state and federal safety regulations.
- Spoil pile approximately 40 feet high, with a 14-acre footprint and 3H:1V slopes.

The Ballast Sourcing Cost Analysis (S&W, 2005a) originally assumed that a ballast quarry would be developed within 20 miles of the alignment. However, during the CRC ballast quarry studies, it became clear that it would be preferable (1) from an economics standpoint that a quarry site should be within a few miles (say 10 miles maximum) and (2) from a strategic construction viewpoint, the quarry site(s) should be near one or both of the ends of the corridor.

The principal parts of the quarry site would include the quarry rock pit, spoil pile, processing/production area, ballast stockpile, settling ponds, water well(s), power generation unit, offices/housing, scales, loading facility, and connecting access/haul roads. A drawing showing a conceptual layout of these components, previously presented in the Ballast Sourcing Cost Analysis (S&W, 2005a), is presented in Figure 1.

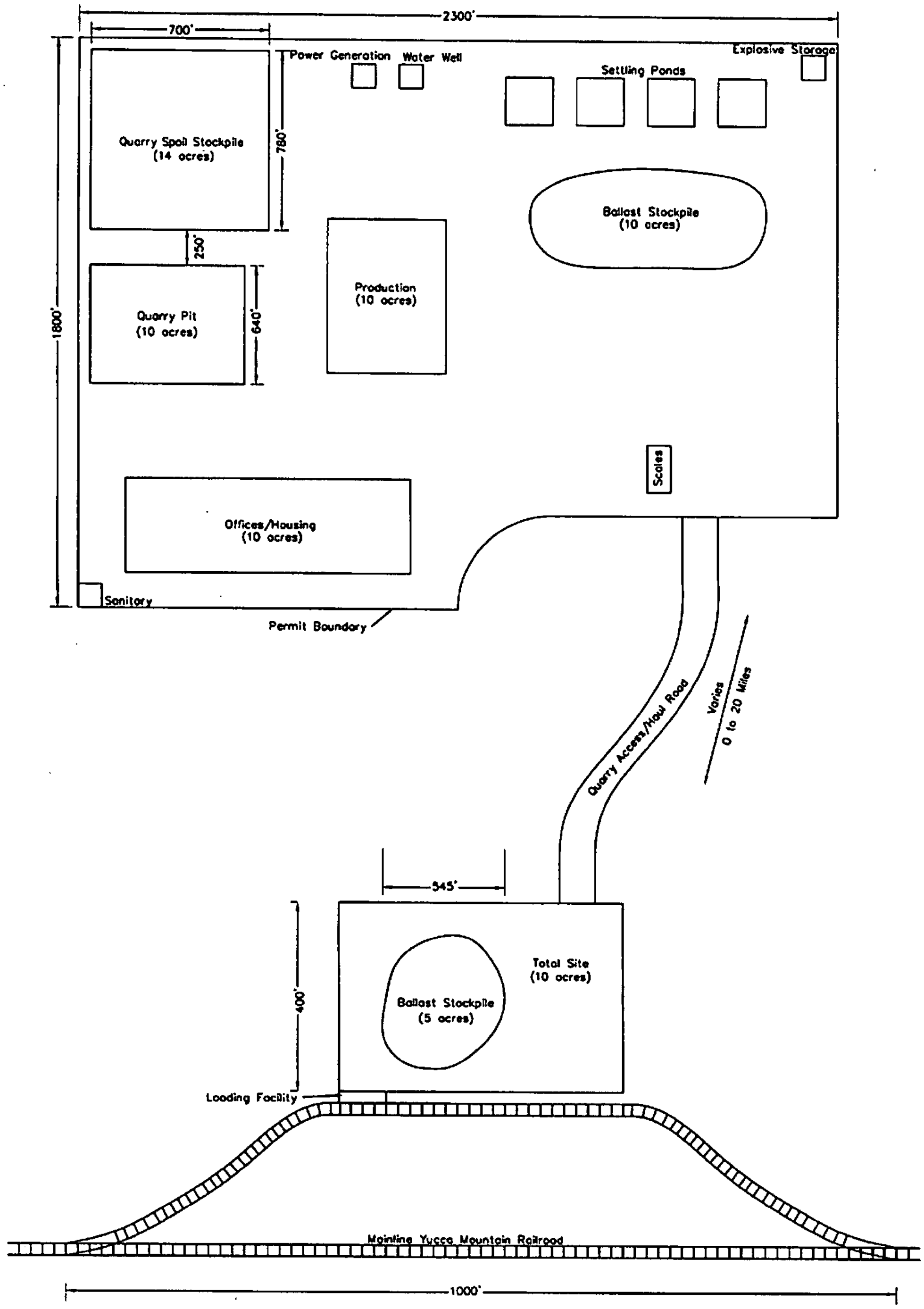

Figure 1. Typical Production Site Layout

A typical quarry headwall about 50 feet high is shown in Figure 2. Some typical parts of the quarry operation are shown in Figures 3 through 5.

Figure 2. Typical Quarry Headwall

Figure 3. Typical Blast Hole Drilling Rig on Headwall

Figure 4. Portable Crushing/Screening Plant

Figure 5. Truck Haulage from Crushed Rock Stockpile

Nevada Rail Partners' (NRP's) estimate calls for approximately 2.7 million in-place[1] tons of crushed rock ballast for new track and yard construction (NRP, 2007). Industry references (Oriard, 2002) indicate that 5 to 25 percent of the in situ rock typically is lost in the hauling, crushing, screening, stockpiling, and transferring process; however, the in situ deposit likely would not be uniform. Some materials unsuitable for ballast would likely be encountered in the quarry pit, especially in layered basalt flows. These unsuitable materials can produce an average of about 25 percent natural loss. Together, the two different losses could add up to 30 to 50 percent loss. The total loss could be on the lower end of this range for granitic rock. At this

[1] "In-place" denotes quantity based on design dimensions and does not include losses or other contingencies.

time, it should be assumed that wastage at various stages of the processing and transportation of the ballast would necessitate a reserve of 5 to 6 million tons for this project. In both cases, these deposits should be considered to be possible or probable reserves (Barksdale, 1991), not proven resources. As such, the potential for loss (from the in situ condition to the railroad alignment) should remain on the high end of the range until subsurface information is available.

Other uses of the same processed rock could potentially be access road surfacing, siding surfacing, erosion control stone, and foundation stabilization material for structures and quarry processing equipment. Oversized rocks that are too large for the crusher jaws could be used for riprap. If the processed rock is used for any of these other purposes, additional tonnage would be necessary.

2.2 Quarry Site Selection List

An initial list of potential ballast quarry sites was generated by S&W. Based on a literature search, which included three county geologic maps at 1:250,000, 28 candidate sources areas were identified within the corridor. Through a collaborative process among BSC, NRP, and S&W, the ballast study was primarily limited to bulbous zones at the north and south ends and within about 10 miles of the proposed MRC (see Plate 1), because of the strategic locations needed for construction of the track.

From the 28 candidate sites, 10 potential quarry sites were selected for additional consideration, as shown in Plate 1. Five of the sites are in the southern end of the alignment (Malpais Mesa South, North Clayton, The Crater, Weepah Hills, and Lone Mountain), one in the central part (Candelaria Hills), and four in the northern end (Gabbs Range, Garfield Hills, Gillis Range, and Weber Dam). All were considered to have rock that would likely be of sufficient quality to meet AREMA standards for ballast rock.

At a meeting on 19 October 2006, Shannon & Wilson presented the attributes of the 10 potential quarry sites to a team comprised of members of DOE, BSC, and NRP. Based on such factors as proximity to the proposed alignment, land status, strategic construction location, and anticipated available rock quantity, the meeting participants chose the five following sites for further study, including field sampling and laboratory testing: Malpais Mesa South, North Clayton, Gabbs

Range, Garfield Hills, and Weber Dam. The locations of these sites are presented in the table below and shown in Plate 1.

QUARRY DESIGNATIONS AND LOCATIONS

Quarry Designation (South to North)	County	Valley/Range
Malpais Mesa South	Esmeralda	Goldfield Hills
North Clayton	Esmeralda	Montezuma Range
Gabbs Range	Mineral	Gabbs Range
Garfield Hills	Mineral	Garfield Hills
Weber Dam	Mineral	White Mountain

3.0 APPROACH TO FIELDWORK

Potential ballast source areas were visited by a field reconnaissance team (Shannon & Wilson MT4) to make additional geologic observations, assess site accessibility, and collect rock samples. Field procedures were outlined in the scope of work and in a NVT Transportation Work Authorization for Fieldwork dated 25 September 2006.

No additional training or orientation was necessary for the field crew, because (1) the five sites had been visited during the initial geologic reconnaissance by teams MT1, MT2, and/or MT3 in late September and early October 2006, and (2) the MT4 team leader had performed similar ballast quarry field evaluations for the CRC in 2005. The site evaluations and sampling were carried out between 28 October and 3 November 2006. Samples of the five sites were delivered to Ninyo & Moore's (N&M's) laboratory in Las Vegas on 6 November 2006.

In general, the quarry team required one to two days to complete an evaluation of a quarry area. The team consisted of a mining engineer and a geologist. They used a Trimble global positioning system (GPS) unit connected to an Archer hand-held computer using ArcPad 7.0 to track their locations and record waypoints of important features in the field. The field team recorded observations in a field book and on field forms created for this project. The completed Quarry Field Evaluation Checklists for each site are presented in Appendix A. They include site observations, preliminary site layouts, and photographs. Biosketches of the team members are presented in Appendix B.

The Shannon & Wilson ballast quarry field team was accompanied throughout the field evaluation and sampling process by Mr. Leroy Laurie, URS archaeologist. Mr. Laurie's purpose was to perform a preliminary assessment of each quarry site for the presence of cultural resources for the ballast quarry sampling process, and to ensure that the sampling did not disturb cultural resources.

3.1 Rock Characterization

Rock strengths were estimated from simple field tests, such as a geologist's rock hammer blows and a Schmidt Hammer, at each potential resource site visited because rock strength roughly correlates with abrasion resistance, toughness, and load bearing. Other attributes of the rock, such as lithology, mineral constituents, vesicularity, oxidation, weathering, and presence or absence of undesirable secondary mineralization, inclusions, and fillings, were assessed visually and recorded in the field notes.

Characteristics of the overall rock mass that could affect quarrying were observed. These included the nature and geometry of structural discontinuities, bedding or flow thickness, continuity of beds or flows, and the presence of voids. The team also noted the presence of partings or seams of undesirable lithologic variations within the rock mass, such as scoria, flow breccia or rubble zones, tuff, shale, and sandstone interbeds. S&W's Field Classification of Rock was used as a guide for the description of rock (Appendix E).

3.2 Quarry Site Characterization

Each potential ballast resource site was assessed for accessibility and potential quarry operational constraints. The distance in miles to existing dirt, gravel, and paved highways was noted, as well as the distance from the proposed rail alignment. The available site size and general site layout and outcrop geometry were assessed in relation to quarry operation and excavation methodology. This included general observations of site topography, estimated mineable thickness of the deposit, and structural attitudes of discontinuities that could adversely impact quarry operations. In general, the quarry teams reconnoitered the entire potential source area before choosing a preferred site for the quarry pit. An outcrop at or near the preferred site was then sampled.

3.3 Other Field Activities

Samples were collected from rock outcrops that were representative of the competent or potentially suitable material for ballast. Because the outcrops contained hard rock, the samples were obtained by dislodging chunks from the outcrop with a 4-pound sledgehammer. Two hundred to 250 pounds of rocks were placed in cloth sacks and labeled. In general, the individual pieces of rock ranged from about 1 to 10 pounds.

Daily work activities were planned each evening. Before entering the field each day, team members discussed the planned work activities, conducted and documented a pre-shift safety meeting, and inspected the vehicle, field equipment, safety equipment, and the other team members' physical and mental condition. Each evening the team reviewed daily progress, reconciled field notes, and reviewed safety issues that came up in the course of the fieldwork. The observations and collected field data were backed up each day by making photocopies of field notebooks and downloading photographs into laptop computers.

Photographs of the areas visited during the field reconnaissance were taken at selected sites. The frame index numbers were recorded in the field notes and with GPS coordinates and direction of view. Photographs are included in Appendix A in each Quarry Field Evaluation Checklist.

4.0 BALLAST CRITERIA AND SUMMARIES OF POTENTIAL QUARRY SITES

4.1 Criteria for Ballast

Ballast from natural rock sources is produced by crushing, screening, and washing quarried rock. As discussed in the Geotechnical Design Criteria Manual (S&W, 2005b), aggregate gradations used as ballast include all five mainline ballast gradations (24, 25, 3, 4A, and 4).

Ballast material should meet the specifications outlined in the AREMA Manual (2007). Material property requirements for processed material include gradation, specific gravity, absorption, degradation, soundness, undesirable particles (clay lumps, friable, flat, elongated) and for some aggregates, chemical analysis. Recommended limiting values of testing for ballast material property requirements are listed in Table 1. In general, it is not possible to evaluate with certainty if a particular source rock would yield material meeting the limiting test values by merely observing the source rock or by taking samples from limited field outcrops. However, at this stage of the project, it was only possible to take samples from field outcrops for testing. The goal of the field reconnaissance team was to take samples that were representative of the suitable rock available in outcrop; however, the degree to which it is representative of the rest of the deposit is unknown. Unsuitable rock, for example weak or highly fractured, was not sampled, but could potentially be a significant percentage of the rock not exposed in outcrop.

Section 2.2 of the AREMA Manual (2007) lists typical properties of acceptable ballast materials as follows:

- Ballast rock should be both hard and dense.
- The rock should have an angular particle structure that provides sharp corners and cubical fragments when crushed.
- The rock should be free of deleterious materials or inclusions.
- The rock should provide high resistance to temperature changes and chemical attack.
- The rock should have high electrical resistance and low water-absorption properties.
- The rock should be free of cementing characteristics.
- The rock should have sufficient unit weight (pounds/cubic foot), and have a limited amount of flat or elongated particles after processing.

The lithologies recommended by AREMA that often yield acceptable materials include granite, traprock, quartzite, limestone, and dolomitic limestone; however, limestone and dolomite are normally not used if other suitable rocks are available. All of the natural rock types listed above occur within a few miles of the alignment. In addition, blast and steel furnace slag (byproducts of industrial processes) and smelter slag can be processed into ballast. Although small smelters processing gold and silver ores operated in portions of central Nevada in the 19th and early 20th centuries, slag in quantities sufficient to meet project requirements was neither observed during the field reconnaissance nor identified from the literature search.

Concrete ties produce greater crushing loads than wood ties; therefore, the AREMA Manual (2007) limits the use of concrete ties to ballast comprised of granite, traprock, or quartzite. Additionally, limestone and dolomite rock fines generated during shipping, handling, placement, tamping, and especially under traffic commonly tend to re-cement, thereby causing problems with drainage, surface levelness, and line of the track structure (AREMA, 2007). Although limestone and dolomite were discussed as possible ballast rocks during 2005 screening studies for the CRC (S&W, 2006a), they were not recommended in that study, and have not been considered during the present study for the MRC. During ballast quarry field studies for the CRC in 2005, quartzite near Caliente was recognized to have issues with brittleness, and was rated poorly for that reason. Because traprock and granite sources were so plentiful on the MRC, quartzite was not seriously considered for use there.

When in situ rock is blasted, it expands significantly to its "loose" or "bulked" condition. This percentage of volume transformation is used to approximate such information as the number of trucks for haulage and the size of crushing and processing equipment. Three references (Church, 1981; Caterpillar, 2006; and U.S. Federal Highway Administration, 2005) indicate that the volume expansion to a loose condition is about 64 to 67 percent for basalt and about 61 to 72 percent for granite.

4.2 Potential Source Rocks

The locations of the potential ballast sources are plotted on Plate 1. Of the 10 sites chosen for further consideration after initial reconnaissance, five were selected as the preferred sites and are shown as red dots and with photographs on Plate 1. The other five sites that were dropped from consideration are highlighted in yellow. In addition, the final five sites are shown in Figures 6 through 11. Maps and photographs of the sites are also included in Appendix A. Two general rock types, basalt/andesite (traprock) and granite, were evaluated. Some characteristics of these rocks are presented below, followed by summaries of each of the five potential ballast source sites.

4.2.1 Basalt and Andesite (Traprock)

Basalt and andesite are dark, fine-grained, extrusive igneous rocks that form at or just below the surface as volcanic lava flows and shallow intrusions. They generally cool very quickly and have a very fine-grained crystalline texture, often containing small, spherical voids (vesicles) formed by the expansion of gas or steam during the solidification of the rock, particularly on the top portion of a flow. Basalt and andesite are considered varieties of "traprock" in the AREMA Manual (2007). Two of the sampled sites contain basaltic rocks.

Traprock is a term used by AREMA (2007) to describe any darker-colored, fine-grained, non-granitic (mainly extrusive) igneous rock. In addition to basalt and andesite, this general definition also includes rhyolite, dacite, rhyodacite, and diabase, all of which occur within the search area. These igneous rocks either are subaerial flows or formed from magma emplaced at relatively shallow depths (hypabyssal rocks) into existing surrounding rock.

4.2.2 Granite

Granite is a plutonic igneous rock consisting chiefly of quartz and feldspars. "Plutonic" refers to rocks that form at considerable depths in the earth's crust from a molten state (magma). Granites cool and crystallize very slowly deep beneath the earth's surface and develop a coarse, crystalline, "granitoid" texture. Eventually, the pluton may be uplifted and exposed at the earth's surface through erosion. Granitic rocks include many varieties, but the most prevalent are granite, granodiorite, quartz monzonite, and pegmatite. Three granite sites were evaluated for this study.

4.3 Summaries of Five Potential Ballast Quarry Sites

The five ballast quarry sites are summarized in the following sections. Individual field descriptions are presented in Appendix A, Quarry Field Evaluation Checklists, in which detailed information is written by the field crew. In the summaries, small maps are included that show the conceptual layouts at each site. They are shown in a broader context on maps in Figures 6 through 11.

4.3.1 Malpais Mesa South Quarry Site Characteristics

The Malpais Mesa South study area (Figure 6) is located about 2 miles southwest of Goldfield, Nevada. On 29 October 2006, roughly 200 pounds of rock samples were collected at waypoint MT4006, at about 6,230 feet elevation.

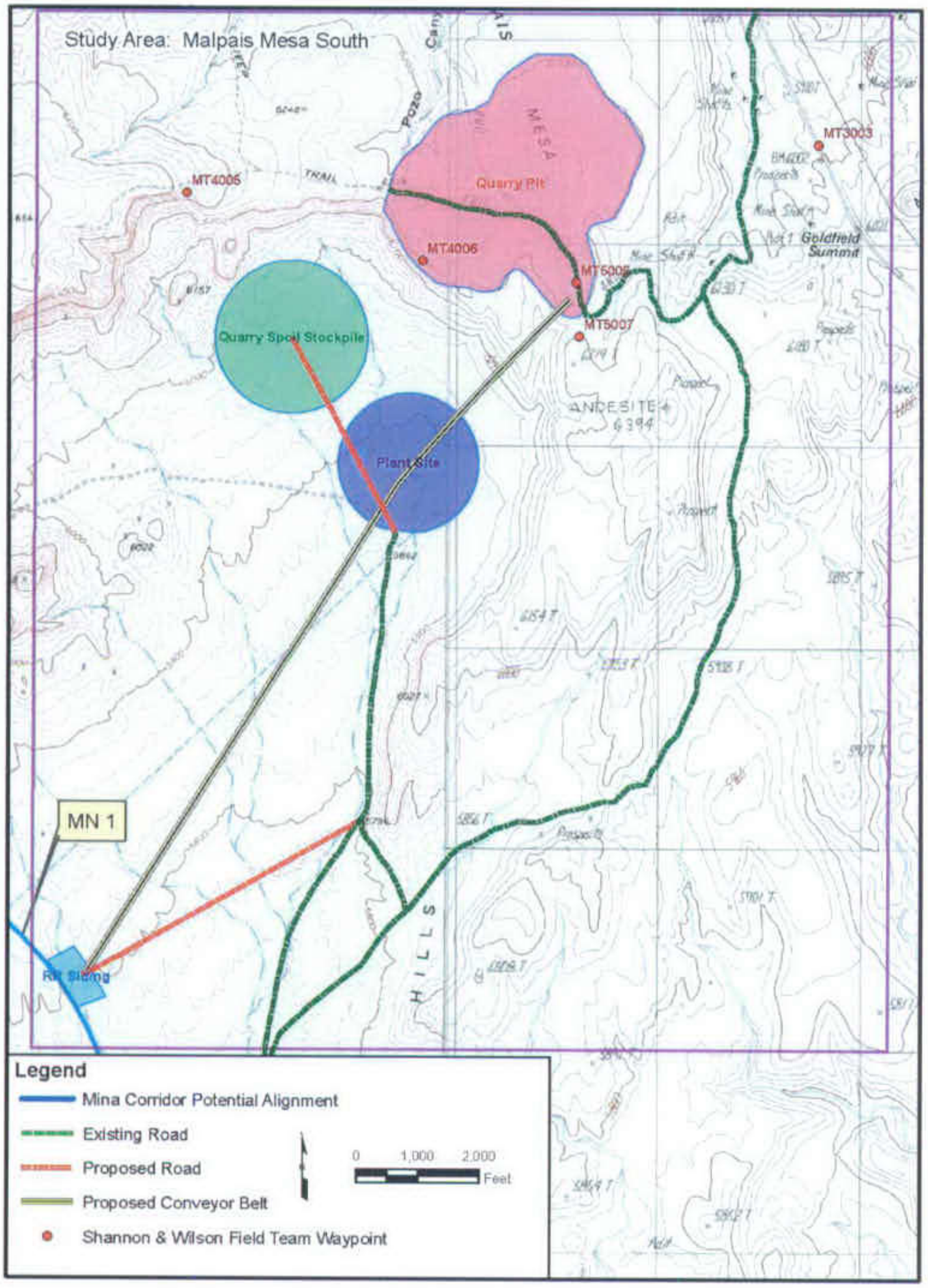

Figure 6. Malpais Mesa South Ballast Quarry Conceptual Layout

The Malpais Mesa South study area covers about 4,870 acres, within which we propose the following features. The areas and lengths are estimates only; but are expected to be upper limits. The actual areas and lengths will depend on the number of quarries and the Contractor's operations.

- Quarry site – ±258 acres
- Quarry spoil stockpile – ±111 acres
- Railroad siding – ±10 acres
- Plant site – ±94 acres
- Conveyor System – 2.6 miles
- Conveyor Quarry to Plant (0.8 mile), Conveyor Plant to Siding (1.8 miles)
- Improved Existing Roads – ±6.0 miles
- New road construction – ±0.4 to 1.7 miles

The study area encompasses a bowl-shaped cliff along the southern edge of Malpais Mesa. Below the cliff, an alluvial fan slopes toward the proposed MN-1 rail alignment, located about 2.5 miles southwest of the quarry.

Malpais Mesa was evaluated for a ballast quarry site in 2005 for the Caliente Corridor. A site was selected at the north end of this expansive mesa where it is in relative proximity to the Caliente Corridor. For the Mina Corridor studies, the mesa was again evaluated, but for a site closer to the MN-1 route. This potential ballast quarry site was designated Malpais Mesa South to distinguish it from the site at the north end of the mesa. Figure 7 shows the relationship of these quarry sites (Malpais Mesa and Malpais Mesa South) in relation to their respective corridors (CRC and MRC).

Access to the study area is from the northeast by way of a jeep trail originating at highway US 95. Grades on this trail average 4 percent with a maximum grade of 16 percent. The trail provides adequate access for exploration drilling during dry weather, but will require significant improvement to provide year-round access for heavy construction and mining equipment. An alternate access to the processing and transport facilities could be from the south via Railroad Springs Road and about 0.4 mile of new roadway. Railroad Springs Road is a well-maintained dirt road.

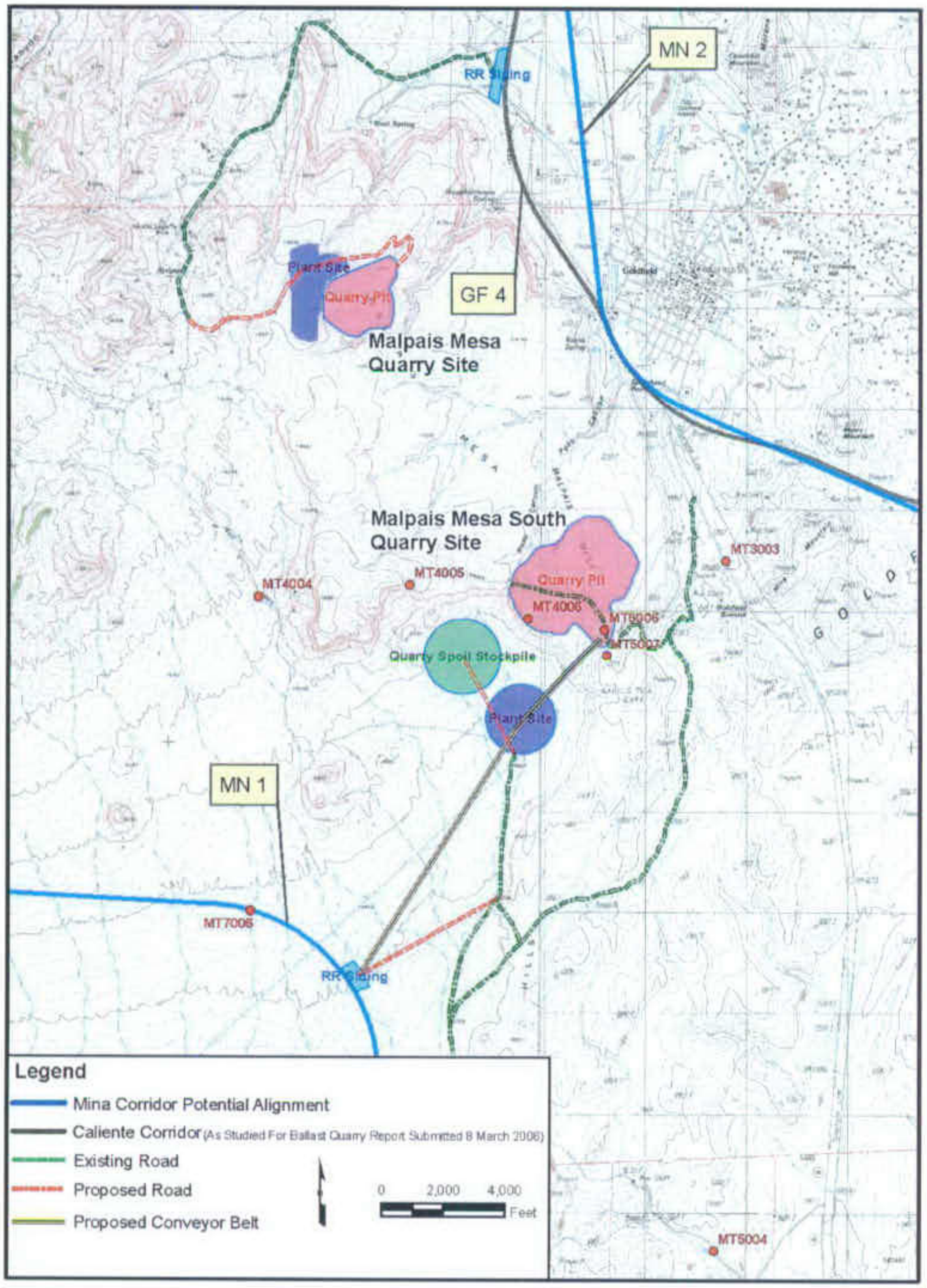

Figure 7. Malpais Mesa (CRC) and Malpais Mesa South (MRC) Quarry Locations

It is difficult to accurately locate BLM leases and mine claims within the study area, because USGS maps of this area do not have section lines. It appears, however, that much of the proposed quarry pit is leased for a potential wind power development project. The processing facilities have been situated to avoid known mining claims to the south and west of the study area. No mine claim posts were seen during field activities.

The proposed quarry pit lies west of US 95 and is accessed by a 2.3-mile jeep trail. Rock in this area consists of porphyritic leucobasalt (basalt hereafter) underlain by welded ash (or tuff). Basalt is the material of interest for ballast. Estimated thickness of the basalt is about 70 feet. Thickness of the underlying tuff is difficult to estimate because outcrops are rare, but may be as thick as 50 feet. It is not considered suitable for ballast.

The basalt is a volcanic rock, consisting mostly of plagioclase feldspar with olivine, magnetite, pyroxenes, and biotite. It is generally very fine grained, having an aphanitic to porphyritic texture, with vesicles most commonly filled with zeolite crystals. It occurs as two separate lava flows. The lower flow is about 30 feet thick, while the upper flow may be as thick as 40 feet. The basalt sampled for this study typically fractures with one to five blows from a standard geologic rock hammer, indicating moderate to medium strength.

Three rock types were observed in the sample outcrop area and are described below:

A. Basalt: moderate to medium strength, gray, fine crystalline; massive, highly vesicular with approximately 90 percent zeolite filled vesicles, jointed; fresh to slightly weathered.

B. Basalt: moderate to medium strength, gray, fine crystalline; massive, highly vesicular with approximately 10 percent zeolite filled vesicles, jointed; fresh to slightly weathered.

C. Tuff: low to moderate strength, red, porphyritic, massive, lineated; slightly weathered. Not suitable ballast material and not sampled for this study.

Ten Schmidt-Hammer field tests were performed at the sample collection site. Test results are presented in the following Table titled "*Malpais Mesa South Schmidt-Hammer Field Test Results*." In all tests, the instrument was oriented perpendicular to the rock surface. Two tuff outcrops were tested (tests 9 and 10) for comparison to the basalt.

MALPAIS MESA SOUTH SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Lithology	Test Surface Dip/Dip Direction
1	40	A	79/060
2	45	A	75/294
3	40	A	30/010
4	46	A	79/036
5	54	B	69/190
6	28	B	82/173
7	44	A	90/254
8	55	A	83/011
9	45	C	82/220
10	32	C	67/154

Block size distribution and rock quality designation (RQD) were visually estimated at the sampling location. Block size distribution is shown in the following Table titled "*Malpais Mesa South Estimated Block Size Distribution.*"

MALPAIS MESA SOUTH ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	10%
4.0 – 6.0 ft	40%
2.0 – 4.0 ft	30%
0.5 – 2.0 ft	15%
< 0.5 ft	5%

It reflects the jointing spacing measured at various locations on the outcrop. Rock quality designation (RQD) of the sampled outcrop is estimated to be 80 to 90 percent. This reflects the vertical jointing and generally massive nature of the outcrop.

Outcrops observed in the study area indicate that the proposed quarry pit will support a multiple-bench operation covering 258 acres with a pit floor at the base of the basalt flows (estimated 6200 elevation). The thickness averages about 70 feet. Quarrying would begin along the southern cliff face and advance to the north. Due to the broad exposure of the top of Malpais

Mesa, additional acreage would likely be available if more material is desired. A quarry pit of these dimensions can produce roughly 13 million total tons of material.

Core drilling is recommended to recover subsurface samples and to characterize the quality of the basalt within the proposed quarry pit. Thirteen proposed locations are recommended during the preliminary exploration phase. The gentle slopes in the Quarry Pit area can be negotiated using a 4WD truck-mounted coring rig with minor dozer preparation for access or track-mounted rig without dozer preparation. The depths range from 27 feet at the northwestern edge of the quarry to 90 feet at the highest point on the mesa. The total estimate of required coring is about 1,000 feet. If these cores indicate that the lower basalt flow has an irregular base, additional coring may be needed to evaluate the quarry pit area.

Surface observations suggest that the proposed quarry pit area is covered with 0 to 5 feet of residual overburden. Actual depths need to be confirmed with borings. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

Conventional drilling and blasting methods appear to be appropriate for this operation. The relatively flat mesa top will permit access using 4WD truck-mounted drilling rigs.

A two-part conveyor system can be used to transport rock from the quarry pit to the plant site and the railroad siding. After blasting, the rock would be transported by conveyor to the plant site. There, it can be crushed and screened to the appropriate AREMA standards. Undersized rock can be used for other purposes, such as subballast, road metal, structural fill, concrete aggregate, and erosion control stone, or stored at the spoil stockpile area. Properly sized ballast stone would then be transported by a second conveyor from the plant site to the railroad siding for transport to the railroad grade.

The conveyor between the quarry pit and the plant site will be about 0.8 mile long. The average slope for this conveyor will be 8 percent, with a maximum slope of 31 percent.

The conveyor between the plant site and the railroad siding will be approximately 1.8 miles long. The average slope for this conveyor will be 1 percent, with a maximum slope of 2 percent. It will be designed to carry railroad ballast.

The proposed railroad siding (Figure 6) encompasses about 10 acres. The elevation of the leveled site would be about 5,810 feet. The average slope across the site is 1 to 2 percent. The site lies on an alluvial fan composed of gravelly, silty sands. This material can be removed using conventional excavation methods. About one mile of new road will need to be built to provide all-weather access to the site for heavy construction equipment.

The proposed plant site (Figure 6) encompasses about 94 acres. The average elevation of the leveled site would be about 5,900 feet. The average slope across the site is 1 percent. This site also lies on an alluvial fan composed of gravelly, silty sand and silty, sandy gravel. It can be regraded using conventional excavation methods. About 3.7 miles of existing jeep trail will need to be improved to provide all-weather access to the site for heavy construction equipment.

The proposed spoil stockpile (Figure 6) encompasses about 111 acres. It is located adjacent to the proposed plant site to minimize new road construction. The average elevation of this site is about 5,970 feet. The average slope across the site is 4 percent. No earthwork will be required to prepare the site. A new 0.7-mile access road will be needed to provide all-weather access to the site for heavy construction equipment.

We do not anticipate any groundwater inflow into the quarry pit during quarrying operations. Seasonal surface water inflow should be minimal. Sloping the pit floor downward and away from the bench face will help prevent water from accumulating in the pit.

No wells or springs were observed within the study area. An abandon aqueduct is present within the study area. It begins near the base of the mesa and trends to the southwest. The aqueduct pipe has multiple breaks and is partially filled with sand. The source of water for this aqueduct appears to have dried up long ago. Wells may need to be drilled to supply water to the site.

There are no existing power lines within the study area. The closest known power line is approximately 1.3 miles to the east at US 95.

4.3.2 North Clayton Quarry Site Characteristics

The North Clayton study area (Figure 8) is located about 9.2 miles northwest of Goldfield, Nevada, and 3.5 miles southwest of Alkali, Nevada. On 30 October 2006, roughly

240 lbs of rock samples were collected from this site at waypoint MT4007, at about 5,500 feet elevation.

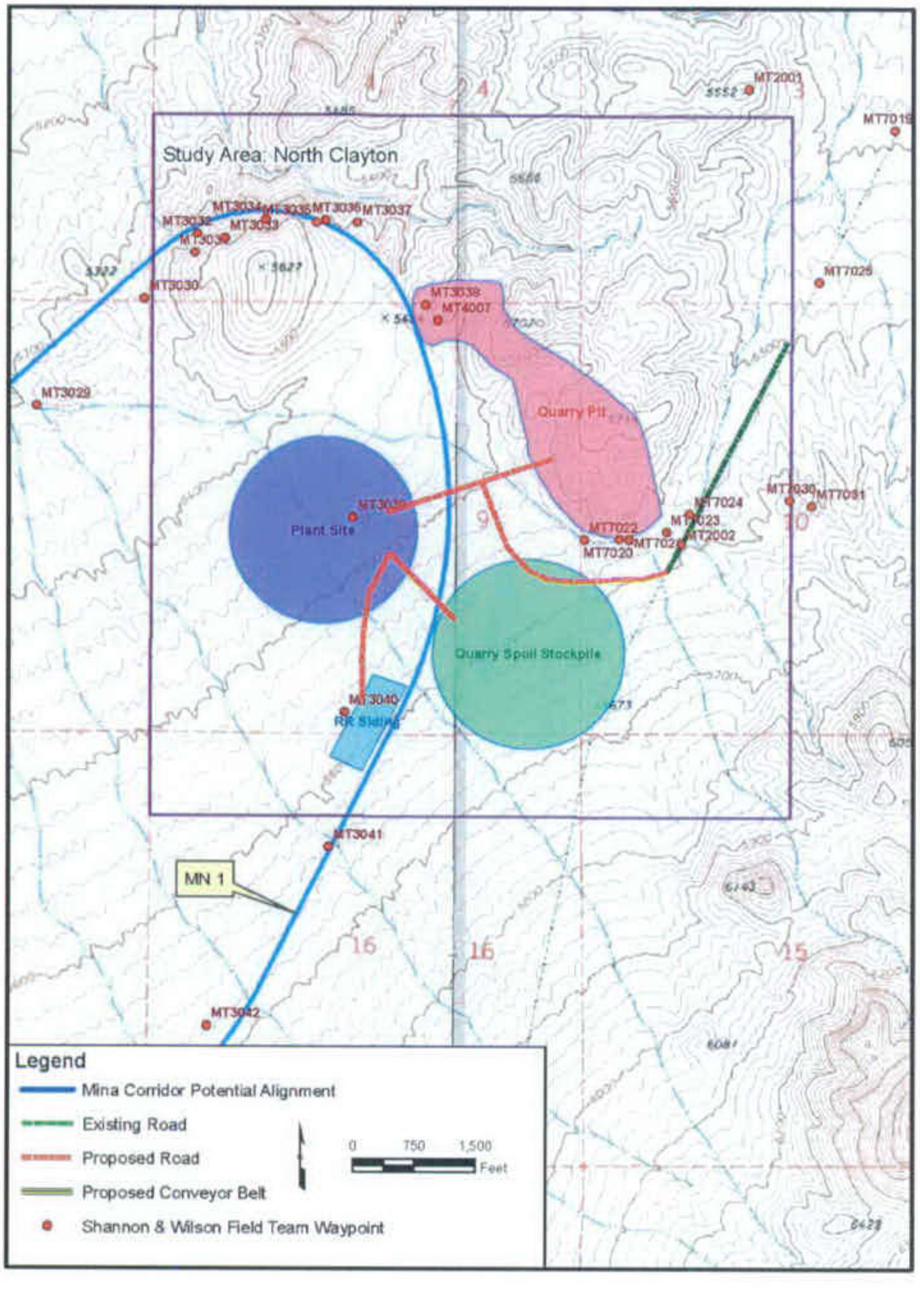

Figure 8. North Clayton Ballast Quarry Conceptual Layout

The study area covers about 1,550 acres, within which we propose the following features. The areas and lengths are estimates only; but are expected to be upper limits. The actual areas and lengths will depend on the number of quarries and the Contractor's operations.

- Quarry site – ±86 acres
- Quarry spoil stockpile – ±99 acres
- Railroad siding – ±11 acres
- Plant site – ±96 acres
- Improved Existing Road – ±3.6 miles (includes improvements to Alkali Spring, not shown on map)
- Road Quarry to Plant (0.4 mile), Road Plant to Siding (0.4 mile)
- New road construction – ±1.3 miles

A northeast-trending ridge dominates topography in the North Clayton study area. Slopes across the study area are moderate to steep. The topography on alluvial fans to the south and east of the study area slopes northwest and north, respectively, at about 4 percent. Areas to the north and west are rougher, with hills and ridges sloping between 5 and 20 percent.

The rock unit of interest in the study area is granite, a plutonic igneous rock composed of quartz, orthoclase, plagioclase, biotite, magnetite, chlorite, muscovite, and calcite. Plutonic refers to rocks that formed at considerable depths in the earth's crust from magmas. The granite cooled slowly and developed a coarse, crystalline texture. Over time, this pluton was uplifted and exposed by erosion. The granite is bordered to the west and north by metamorphosed (altered) shale, sandstone, and limestone.

Access to the study area is by way of an existing jeep trail adjacent to a power line that originates at Alkali, runs southwesterly for a distance of 6.3 miles, then terminates at a rural road south of the study area. The quarry site is adjacent to this road and about 3.4 miles southwest of Alkali. The sample site (MT4007) is located about 1 mile northwest of the dirt road and is accessed by an unmapped jeep trail. The average grade on the trails is about 3 percent with a maximum grade of 7 percent. These trails provide adequate access for exploration drilling during dry weather, but will require improvement to withstand year-round use by heavy construction and quarrying equipment.

Portions of this ridge, outside the study area, are claimed for mining. The study area, however, does not appear to host any active leases or claims. A few mine claim posts are visible within the study area, but they appear to be dormant, with no signs of recent mining or exploration activity.

The granite at the sample site fractures with 5 to 10 blows from a standard geologic rock hammer, indicating medium high strength. Nine Schmidt-hammer field strength tests were performed at the sample collection site. Test results are presented the following Table titled "*North Clayton Schmidt-Hammer Field Test Results*." The rocks tested were generally fresh; slight weathering on some test surfaces did not seem to affect the results. During all tests, the instrument was oriented perpendicular to the rock surface.

Visual estimates of block size distribution and rock quality designation (RQD) were performed during sampling. Block size distribution is shown in the following Table titled "*North Clayton Estimated Block Size Distribution*." This reflects the measured jointing spacing visible in the outcrop. RQD of the sampled outcrop is estimated at 70 to 85 percent. This too, reflects the jointing and generally massive nature of the outcrop.

NORTH CLAYTON SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/Dip Direction
1	58	59/002
2	52	90/176
3	52	19/098
4	51	68/200
5	61	60/229
6	59	69/229
7	58	80/159
8	49	80/168
9	48	70/170

NORTH CLAYTON ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	10
4.0 – 6.0 ft	50
2.0 – 4.0 ft	25
0.5 – 2.0 ft	15
< 0.5 ft	5

We anticipate a multiple-bench quarry operation covering about 86 acres at a maximum final bench height of about 50 feet. An estimated 13.6 million tons of stone is extractable from this deposit based on the selected 86-acre area.

Core drilling is recommended to recover subsurface samples and to allow better characterization of the quality of the granite within the proposed quarry pit. Eight proposed locations are recommended during the preliminary phase of exploration. Track-mounted core drills will be required to access the steep slopes in the proposed quarry pit, with prepared pioneer trails and dozer assistance in some places. Estimated drilling depths vary from 45 feet in the western portion of the quarry to 170 feet at the highest point of the ridge. Total coring footage is estimated to be about 800 feet.

Quarrying could commence at various locations near the base of the ridge and advance toward higher elevations. It should advance to limits of the quarry pit as shown in Figure 8, except where topography limits accessibility. On completion of quarrying, the final high wall height may be about 150 feet.

Surface observations suggest that the proposed pit area is covered with 0 to 3 feet of residual overburden. Actual soil depths will have to be confirmed with borings, but if the overburden is as thin as we anticipate, it may be feasible to separate it from the stone by screening the shot rock rather than removing it mechanically from the bench top prior to drilling.

Conventional drilling and blasting methods appear to be appropriate for this operation. Steep slopes in the pit area will require the use of track-mounted production drills.

After blasting, the rock will be crushed and screened to the appropriate AREMA standards. Undersized rock can be used for other purposes, such as subballast, road metal, structural fill, concrete aggregate, and erosion control stone, or stored as spoil. The stone would be hauled by truck from the quarry to the plant site and then to the railroad siding for use as ballast.

The railroad siding area encompasses approximately 11 acres. The surface slopes downward from the alignment at 5 percent average grade. The nearby spoil stockpile area can serve as a borrow pit for fill for the siding during construction. It lies on a large alluvial fan composed of gravelly, silty sands and sandy gravel. This soil should be acceptable for fill and can be removed using conventional excavation methods.

The plant site area encompasses approximately 96 acres. Like the railroad siding, the surface slopes downward from the alignment, but at 3 percent average grade. Again, the spoil pile area can serve as a borrow pit for fill for the plant site.

No wells or springs were noted within the production area. The closest observed water source is at Alkali, located about 3.4 miles northeast of the study area. At the time of our visit, a privately owned hot spring there was producing 10 to 20 gallons per minute (gpm) of non-potable water. Wells may need to be drilled at the site or water may need to be transported to the site.

An existing power line runs through the southeastern quadrant of the study area. This power line is approximately 1 mile east of the plant site and is shown in Figure 8.

4.3.3 Gabbs Range Quarry Site Characteristics

The Gabbs Range study area is located about 3.3 miles northwest of Luning, Nevada, and US 95. Current access to site is shown in Figure 9. The rock samples taken at this site were collected at about 5,000 feet elevation.

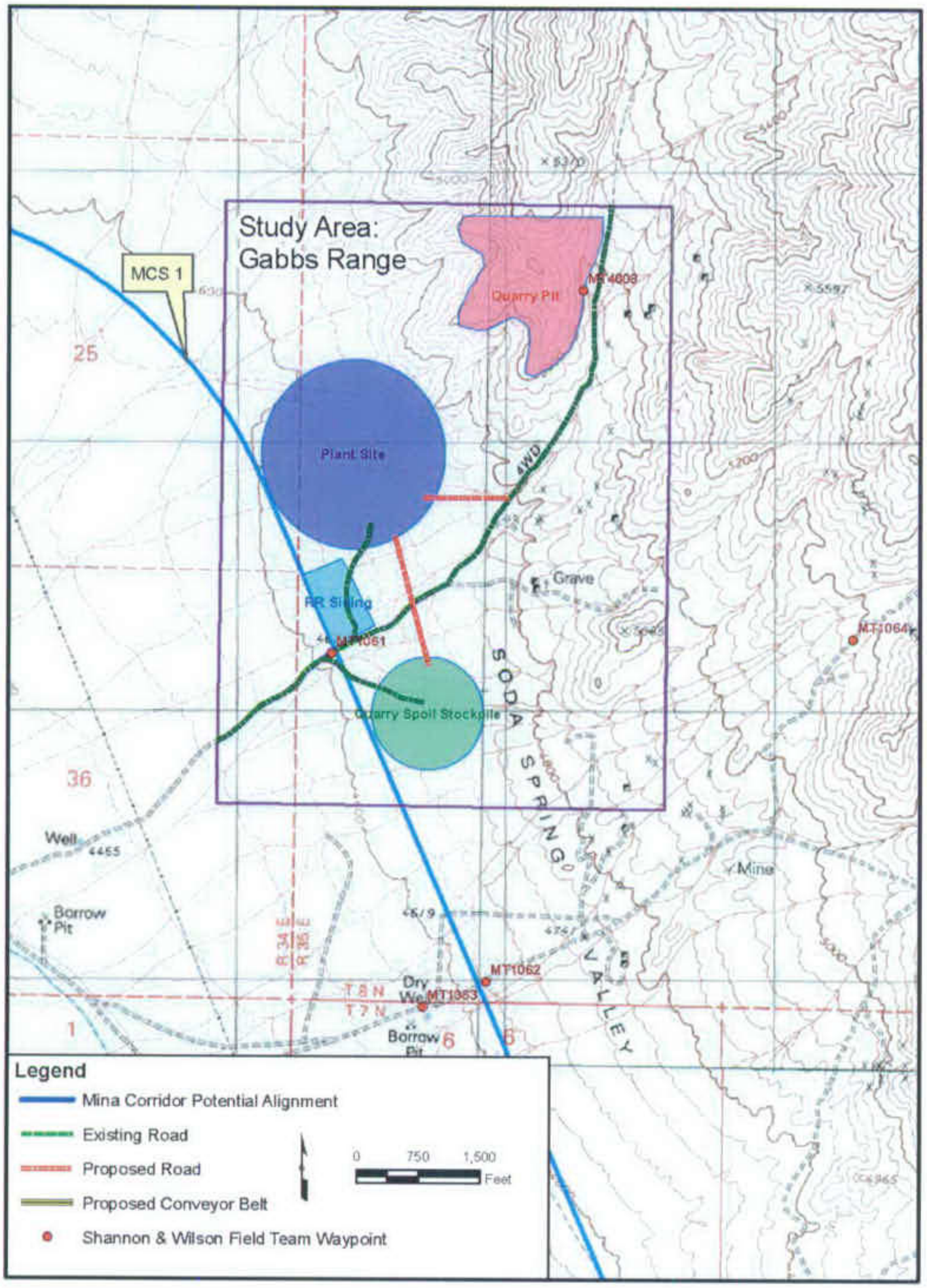

Figure 9. Gabbs Range Ballast Quarry Conceptual Layout

The study area covers about 915 acres, within which we propose the following features. The areas and lengths are estimates only; but are expected to be upper limits. The actual areas and lengths will depend on the number of quarries and the Contractor's operations.

- Quarry site – ±52 acres
- Quarry spoil stockpile – ±34 acres
- Railroad siding – ±12 acres
- Plant site – ±93 acres
- Improved Existing Roads – ±4.6 miles (includes improvements to Luning, not shown on map)
- Road quarry to plant (0.7 mile), Road plant to siding (0.2 mile)
- New road construction – ±0.5 mile

The Gabbs Range study area is enclosed in a north-trending ridge that includes older sedimentary and other plutonic rocks. Slopes across the study area vary greatly due to multiple hills and ridges. The topography to the southwest of the study area is smoother with a gentle alluvial fan slope down to a playa and salt marsh.

The material of interest in the study area is a granite intrusion. The intrusive material is bordered to the east and west by older metamorphosed sedimentary rocks and to the south by a dry wash. Granite is an igneous rock that has quartz and orthoclase and plagioclase feldspars. It may also contain such minerals as magnetite, biotite, and hornblende. The granite has a phaneritic texture. It intrudes the older metasediments creating irregular contacts across the study area. These contacts may limit horizontal expansion of the quarry area. In a few scattered areas, a weaker, dike-like, coarse-grained, granitic intrusion cuts the granite. This rock does not appear to be suitable for ballast material.

The study area is accessed by way of an approximately 4.2-mile dirt road east of the study area. The dirt road begins at Luning (US 95) and borders a low-lying playa/salt marsh. The road then turns to the east and heads into the Gabbs Range. The grade on this road averages about 2 percent, with a maximum grade of 11 percent. This road is adequate for exploration drilling during dry weather but will require improvement to withstand year-round use by heavy construction and quarrying equipment.

We understand that a mining claim exists in the Southeast Quadrant of Township 8 North, Range 35 East, which also contains a portion of the study area. According to LR-2000 maps, the mining claim lies outside the study area. We encountered only a few mine claim posts within the study area, and they appeared to be inactive at the time of our reconnaissance.

The granite rock we sampled typically fractures with 15 to 20 blows from a standard geologic rock hammer, indicating high strength. Ten Schmidt-Hammer field tests were performed at the sample collection site. Test results are presented in the following Table titled "*Gabbs Ridge Schmidt-Hammer Field Test Results*." In all tests, the instrument was oriented perpendicular to the rock surface. Visual field estimates of block size distribution and RQD were performed at the sampling location.

GABBS RANGE SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/Dip Direction
1	68	50/280
2	40	50/280
3	40	60/071
4	59	58/026
5	70	75/310
6	63	80/103
7	48	64/310
8	58	73/105
9	57	44/352
10	60	46/237

Estimated block size distribution is given in the following Table titled "*Gabbs Ridge Estimated Block Size Distribution*." Our RQD estimate of the sampled outcrop is 50 to 70 percent. This too, reflects the closely spaced jointing of the outcrop.

GABBS RANGE ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 1.0 ft	20
0.5 – 1.0 ft	50
< 0.5 ft	30

We anticipate a multiple-bench quarry operation covering an area of approximately 52 acres with a maximum bench height of about 100 feet. A quarry pit of these dimensions could produce approximately 14 million total tons of stone.

We examined a number of outcrops, located along the eastern portion of the ridge exposed within the dry wash in the northern portion of the study area. However, to characterize the quality of the granite within the footprint of the proposed quarry, we recommend drilling ten core holes. Track-mounted core drills will be required to access the steep sloping drill sites in the proposed quarry pit. Bulldozers may also be required to aid in sloping the hillside/breaking trail for the drill rig to ascend the hillsides. Estimated drilling depths vary from 60 feet in the south portion to 220 feet in the northwestern portion of the quarry pit. The total estimate of required coring is 1,200 feet.

Quarrying should begin at the eastern edge of the pit next to the access road. It should advance to the limits of the quarry pit as shown in Figure 9, except where topography limits accessibility. On completion of quarrying the final high wall height may be about 100 feet. It is unlikely that the quarry operations will be visible from Luning.

Surface observations suggest that the proposed pit area is covered with 0 to 5 feet of residual overburden. Actual depths would have to be confirmed with borings. If the overburden is as thin as we anticipate, it may be feasible to separate it from the stone by screening the shot rock rather than removing it mechanically from the bench top prior to drilling.

Conventional drilling and blasting methods are appropriate for this operation. The steep slopes of the pit area may require the use of track-mounted drills.

After blasting, the rock should be crushed and screened to the appropriate AREMA standards. Undersized rock can be used for other purposes, such as subballast, road metal, structural fill, concrete aggregate, and erosion control stone, or stored as spoil. The stone would be hauled by truck from the quarry to the plant site and then to the railroad siding for use as ballast.

The railroad siding area encompasses approximately 12 acres. The average elevation of the site would be approximately 4,650 feet. The site lies at the toe of the ridgeline within a Quaternary alluvium slope and is most likely composed of gravelly, silty sands and sandy gravel. It is our opinion that the material may be removed or regarded using conventional excavation methods. Due to topographic conditions, the railroad siding area may be visible from Luning and US 95.

The plant site area would encompass approximately 93 acres. The average elevation of the site would be approximately 4,675 feet. The site lies within a Quaternary alluvium slope and is most likely composed of gravelly, silty sand and silty, sandy gravel. It is our opinion that the material may be removed using conventional excavation methods. Due to topographic conditions, the plant site will likely be visible from Luning and US 95.

We do not anticipate groundwater inflow during quarrying operations. Seasonal surface water inflow may occur. We recommend sloping the pit floor downward and away from the bench face to avoid any water accumulation that may occur in the pit. The southern and eastern edges of the quarry pit are bordered by a dry wash. The presence of large boulders, wide cuts (10 to 15 feet), and deep cuts (3 to 5 feet) indicate the possibility of large water flow during the rainy season. The access road also travels along this wash and may need to be relocated for year-round use.

No wells or springs were observed within the production area. A well casing was observed approximately 1.8 miles to the southwest along the prepared access road. A dry well is shown on the USGS topographic map about one mile southeast of the proposed railroad siding. Wells may need to be drilled or water may need to be transported to the site.

An existing power line runs northwest to southeast along the western front of the study area. This power line is approximately 4,000 feet west of the plant site and is shown in Figure 9.

4.3.4 Garfield Hills Quarry Site Characteristics

The Garfield Hills study area is located about 8 miles east of Hawthorne, Nevada. Current access to site is shown in Figure 10. The rock samples for Garfield Hills were collected at about 4,840 feet elevation.

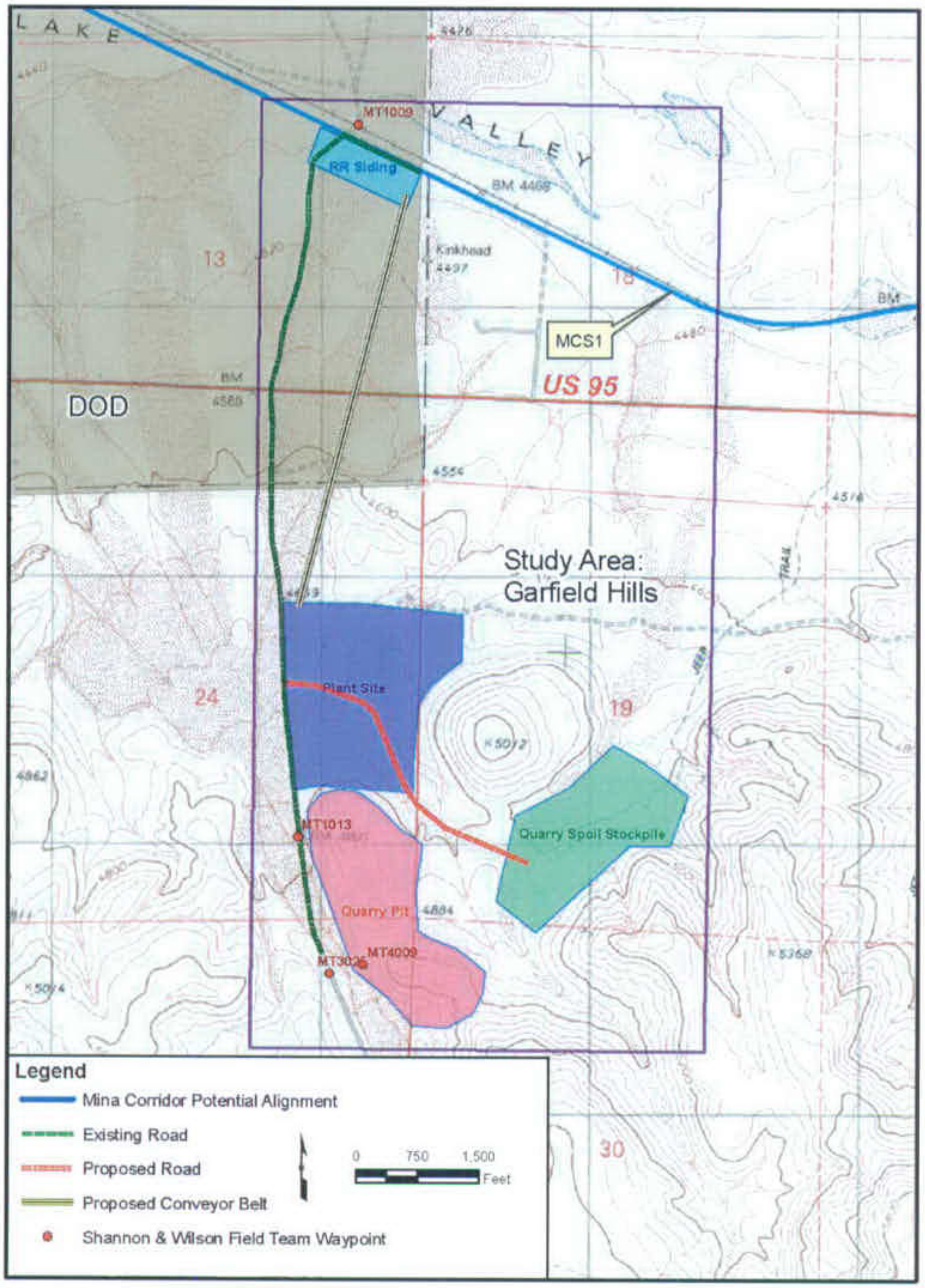

Figure 10. Garfield Hills Ballast Quarry Conceptual Layout

The study area covers about 1,120 acres, within which we propose the following features. The areas and lengths are estimates only; but are expected to be upper limits. The actual areas and lengths will depend on the number of quarries and the Contractor's operations.

- Quarry site – ±74 acres
- Quarry spoil stockpile – ±61 acres
- Railroad siding – ±14 acres
- Plant site – ±94 acres
- Conveyor System (Plant to siding) – 1 mile
- Improved Existing Road – ±2.4 miles
- Road quarry to plant (0.6 mile)
- New road construction – ±0.9 mile

The study area encompasses a north-trending mesa with low rising hills along the northern front. The topography to the north becomes a relatively flat-lying alluvial fan extending gently to US 95. The western edge of the study area is bordered by a dry wash and by Garfield Flats Road, a well-maintained, gravel, access route. The southern and eastern portions of the study area rise to a flat-lying mesa.

The hills in the study area are composed of multiple basalt lava flows with scoriaceous and rubble zones between flows. Basalt is a low-silica igneous, volcanic rock. It is mafic in composition and consists mostly of plagioclase feldspar, olivine, pyroxene, iddingsite, magnetite, and calcite. It has an aphanitic texture containing vesicles that increase in size and abundance in the upper portions of each flow. These vesicles are partially filled with zeolite crystals.

The basalt flows are separated by scoriaceous zones ranging from 2 to 5 feet thick. Locally, the scoriaceous zones extend vertically through the basalt flows. These zones are considered unsuitable for ballast material. Additionally, the basalt is moderately jointed and fractured. The upper portion of the basalt flow package is covered with approximately 5 feet of overburden consisting of silty sand mixed with weathered basalt gravel.

The quarry site is about 1.2 miles south of US 95, accessed by a gravel road. The grade on this road averages about 3 percent, with a maximum grade of 6 percent. This road is in excellent condition and is adequate for exploration drilling during dry weather. Additional crushed rock may have to be added for all-weather use by heavy construction equipment.

We understand from the LR-2000 database that south of the study area, within Township 8 North, Range 32 East, Sections 30 and 31, mining claims exist. According to maps, these claims lie outside our study area and should not be affected by the quarry, nor should they affect the quarry. The northwest part of the study area is the Hawthorne Ammunition Depot, as shown in Figure 10. We encountered only a few mine claim posts within the study area, and they appeared to be inactive at the time of our reconnaissance.

The basalt rock we sampled typically fractures with 15 to 20 blows from a standard geologic rock hammer, indicating high strength. Ten Schmidt-Hammer field tests were performed at the sample collection site. Test results are presented in the following Table titled "*Garfield Hills Schmidt-Hammer Field Test Results.*" In all tests, the instrument was oriented perpendicular to the rock surface. Visual field estimates of block size distribution and rock quality designation (RQD) were performed at the sampling location. Estimated block size distribution is given in the following Table titled "*Garfield Hills Estimated Block Size Distribution.*"

GARFIELD HILLS SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/Dip Direction
1	52	90/215
2	53	71/246
3	58	63/168
4	52	88/174
5	38	81/121
6	47	30/135
7	57	63/270
8	60	71/156
9	54	80//074
10	50	68/114

GARFIELD HILLS ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	5
4.0 – 6.0 ft	10
2.0 – 4.0 ft	15
0.5 – 2.0 ft	50
< 0.5 ft	20

This reflects the measured joint spacing and fractures visible in the outcrop. Our RQD estimate of the sampled outcrop is 40 to 60 percent, which also reflects the moderately jointed and fractured nature of the rock.

We anticipate a multiple-bench quarry operation covering an area of approximately 74 acres with a maximum bench height of about 100 feet. A quarry pit of these dimensions will produce approximately 42 million total tons of stone.

We examined numerous areas of the outcrop located at various elevations along the western edge of the study area. However, to preliminarily characterize the geologic conditions and quality of the basalt within the footprint of the proposed quarry, we recommend drilling 14 core holes. Drilling explorations can be performed using a track-mounted drill rig, with dozer preparation and assistance being necessary in some cases. Estimated drilling depths range from 50 feet at the northern edge of the quarry to 180 feet at the highest points of the southern hill. The total estimate of required coring is about 1,400 feet. If the recommended borings find an irregular base to the basalt flows, additional borings may be required to define the quarry extents.

Quarrying could advance south to the limits of the quarry pit as shown in Figure 10. On completion of quarrying, the final high wall height would be about 200 feet.

Surface observations suggest that the proposed pit area is covered with 0 to 5 feet of residual overburden. Actual depths will have to be confirmed with borings. If the overburden is as thin as we anticipate, it may be feasible to separate it from the stone by screening the shot rock rather than removing it mechanically from the bench top prior to drilling.

Conventional drilling and blasting methods are appropriate for this operation. The slope of the hill surface will mostly require using a track-mounted, hydraulic powered drilling system.

After blasting, the rock will be crushed and screened to the appropriate AREMA standards. Undersized rock can be used for other purposes, such as subballast, road metal, structural fill, concrete aggregate, and erosion control stone, or stored as spoil. The ballast stone would be hauled by truck from the quarry to the plant site and then transported by conveyor belt to the railroad siding, across US 95.

The railroad siding area encompasses approximately 14 acres. The average elevation of the site is approximately 4,485 feet. This site is relatively flat lying. Excavation at this site would be minimal. Due to topographic conditions and location of the proposed railroad alignment, the railroad siding area will be visible from US 95. In order to access this site, crossing the military reservation is necessary. The boundary of the military reservation is noted in Figure 9.

The plant site area encompasses approximately 94 acres. The average elevation of the site is approximately 4,700 feet. The site lies within an alluvial fan deposit (average slope is 4 percent, and maximum slope is 9 percent) and is most likely composed of gravelly, silty sand and silty, sandy gravel. We anticipate that the material can be removed or regarded using conventional excavation methods. Due to topographic conditions, the plant site area may be visible from US 95.

We do not anticipate groundwater inflow during quarrying operations. Seasonal surface water inflow would be minimal. We recommend sloping the pit floor downward and away from the bench face to avoid water accumulation that may occur in the pit. A dry wash borders the western edge of the study area. Scattered boulders are present within the wash. These boulders have been deposited during times of substantial water flow. It may be necessary to mitigate water flow during the rainy season.

No wells or springs were observed within the production area. Wells may need to be drilled or water may need to be transported to the site.

An existing power line runs east-west through the middle of the study area. This power line would run adjacent to the plant site and is shown in Figure 10.

4.3.5 Weber Dam Quarry Site Characteristics

The Weber Dam Quarry study area is located about 6 miles northwest of Schurz, Nevada, and about 0.8 mile southwest of US 95A. Current access to site is shown in Figure 11. The rock samples for this site were collected at about 4,710 feet elevation.

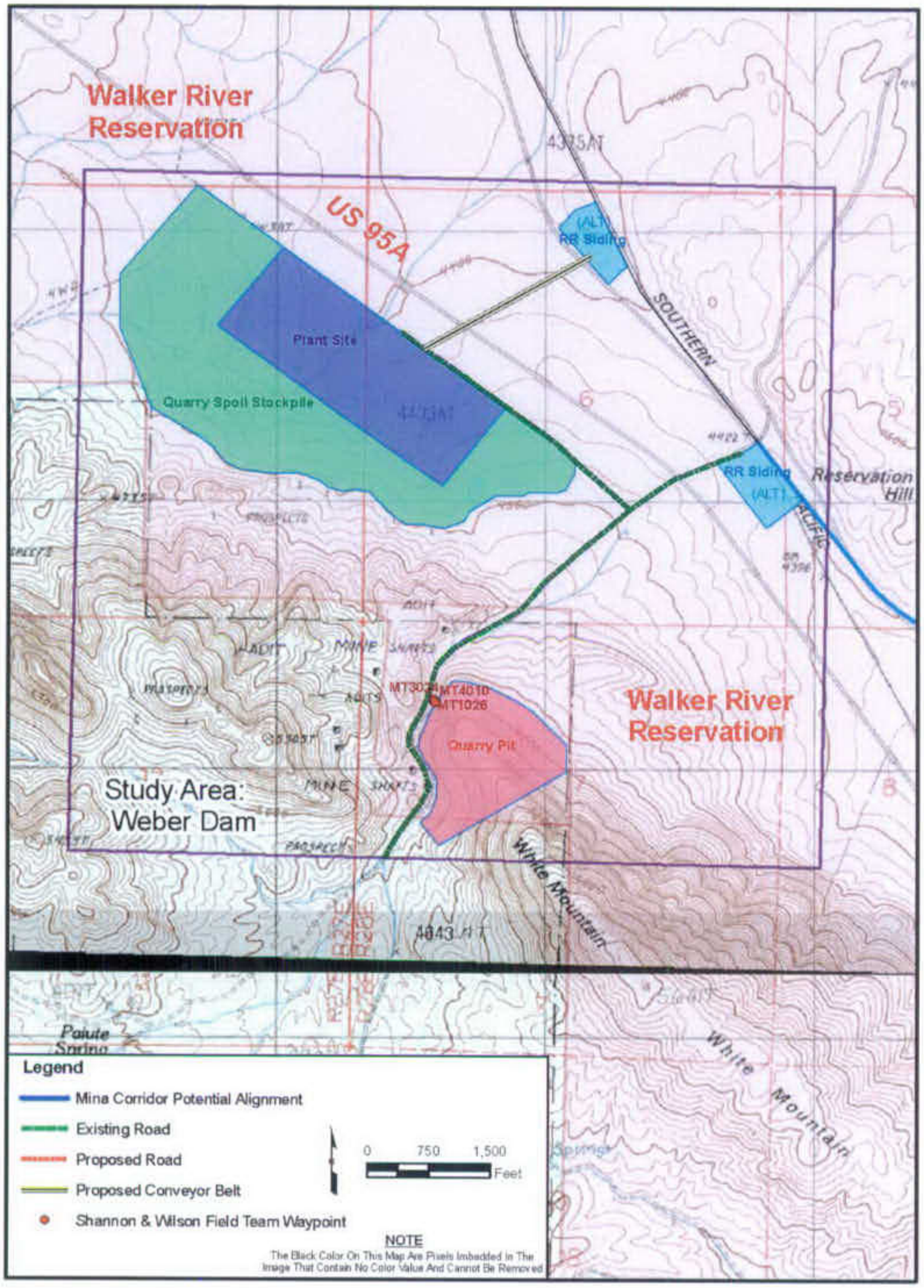

Figure 11. Weber Dam Ballast Quarry Conceptual Layout

The study area covers about 1,800 acres, within which we propose the following features. The areas and lengths are estimates only; but are expected to be upper limits. The actual areas and lengths will depend on the number of quarries and the Contractor's operations.

- Quarry site – ±52 acres
- Quarry spoil stockpile – ±100 acres
- Railroad siding – ±9 acres
- Plant site – ±96 acres
- Alternative conveyor system – ±0.44 mile
- Improved Existing Roads – ±1.9 miles
- Road quarry to plant (1.3 miles), Road plant to siding (1 mile)

The Weber Dam Quarry study area is in the northwestern end of White Mountain, which is a northwest-trending ridge of plutonic, sedimentary, and volcanic rocks. The slope gradients in the quarry area are steep to precipitous. The topography to the northeast and east of the study area becomes smoother, with a gentler slope down toward the Walker River. The area to the west and south consists of multiple hills and rougher terrain. A dry wash borders the material of interest along the western edge of the outcrop. All components of the Weber Dam Quarry site are located in the Walker River Indian Reservation.

The material of interest in the study area is a granite intrusion. The intrusive material is bordered to the north by older metamorphosed sedimentary rocks and older volcanic rocks. Granite is a high-silica igneous rock that has approximately equal proportions of orthoclase and plagioclase feldspars. It may also contain such minerals as hematite, muscovite, biotite, and hornblende. The granite has a phaneritic texture. Multiple thin shear zones exist within the material. These zones are highly fractured and contain sparry calcite. The thickness of the shear zones ranges from 1 inch to 1 foot. These shear zones would not make suitable ballast material. In addition, pegmatitic dikes cut the outcrop. These dikes range from a few inches to 2 feet thick. The pegmatites contain feldspar, quartz, and micas. They do not appear to weaken the outcrop by any significant amount; however, the extremely coarse grains may weather faster than the finer-grained granite. The granite in the study area was reportedly previously quarried in the 1930s for erosion protection during construction of Weber Dam, located approximately 3.2 miles to the northeast. It is assumed that quarrying would restart at the face of the former quarry operation.

The quarry area is accessed by way of an approximately 4,100-foot dirt road southwest of US 95A. The gradient on this road averages about 5 percent, with a maximum grade of 12 percent. This road is adequate for exploration drilling during dry weather but will require improvement to withstand year-round use by heavy construction and mining equipment.

We understand that no mining claims exist within the study area, based on the LR-2000 database. We encountered only a few mine claim posts and older prospect pits within the study area, and they appeared to be inactive at the time of our reconnaissance.

The granite rock we sampled typically fractures with 15 to 30 blows from a standard geologic rock hammer, indicating high to very high strength. Ten Schmidt-Hammer field tests were performed at the sample collection site. Test results are presented in the following Table titled "*Weber Dam Quarry Schmidt-Hammer Field Test Results*." In all tests the instrument was oriented perpendicular to the rock surface. Visual field estimates of block size distribution and rock quality designation (RQD) were performed at the sampling location.

WEBER DAM SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/Dip Direction
1	57	82/100
2	66	81/219
3	68	81/219
4	62	20/305
5	60	44/274
6	62	68/234
7	64	69/232
8	47	22/120
9	62	77/290
10	62	67/135

Estimated block size distribution is given in the following Table titled "*Weber Dam Quarry Estimated Block Size Distribution*." Our RQD estimate of the sampled outcrop is 20 to 30 percent. This too, reflects the jointing and fracturing observed in the outcrop.

WEBER DAM ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	0
4.0 – 6.0 ft	5
2.0 – 4.0 ft	15
0.5 – 2.0 ft	50
< 0.5 ft	30

We anticipate a multiple-bench quarry operation covering an area of approximately 52 acres. A quarry pit of these dimensions could produce approximately 33 million total tons of stone.

We examined numerous areas of the outcrop located along the western portion of the ridge exposed within the dry wash. However, to characterize the quality of the granite within the footprint of the proposed quarry, we recommend drilling 10 core holes. Track-mounted core drills would be required to access most of the steep sloping quarry pit (with dozer trails and assistance), and some areas would need helicopter assistance. Estimated drilling depths vary from 60 feet in the northern portion to 390 feet on the highest point of the hill within the quarry pit. The total estimate of required coring is 1,660 feet.

Quarrying should begin at the northern edge of the pit. It should advance to the limits of the quarry pit as shown in Figure 11. On completion of quarrying, the final high wall height may be about 400 feet but with one or more mid-slope benches.

Surface observations suggest that the proposed pit area is covered with 0 to 5 feet of residual overburden. Actual depths would have to be confirmed with borings. If the overburden is as thin as we anticipate, it may be feasible to separate it from the stone by screening the shot rock rather than removing it mechanically from the bench top prior to drilling.

Conventional drilling and blasting methods are appropriate for this operation. The steep slopes of the pit area will require the use of track-mounted drills.

After blasting, the rock should be crushed and screened to the appropriate AREMA standards. Undersized rock can be used for other purposes, such as subballast, road metal, structural fill, concrete aggregate, and erosion control stone, or stored as spoil. The stone could be hauled by truck from the quarry to the plant site and then to the railroad siding for use as ballast. Alternatively, a conveyor belt could be built to transport ballast to the siding, across US 95A.

The railroad siding area encompasses approximately 9 acres. The average elevations of the alternative sites would be approximately 4,390 and 4,430 feet. This site is relatively flat-lying. Excavation at this site would be minimal. Due to topographic conditions and the proximity of the proposed railroad alignment, the railroad siding area may be visible from US 95A. This site is located on the Walker River Reservation adjacent to the proposed railroad alignment. An alternative siding is shown for receiving ballast from a conveyor system.

The plant site area would encompass approximately 96 acres. The average elevation of the site would be approximately 4,425 feet. The site lies within a Quaternary alluvium slope and is most likely composed of gravelly, silty sand and silty, sandy gravel. It is our opinion that the material may be removed or regarded using conventional excavation methods. Due to topographic conditions, the plant site may be visible from US 95A.

We do not anticipate groundwater inflow during quarrying operations. Seasonal surface water inflow may occur. We recommend sloping the pit floor downward and away from the bench face to avoid water accumulation that may occur in the pit. The western edge of the quarry is bordered by a dry wash. Surface water may flow through this wash during the rainy season. The access road also travels along this wash and may need to be relocated for year-round use.

No wells or springs were observed within the production area. Walker River/Weber Reservoir is present approximately 3.2 miles to the northeast. This river and reservoir are located on the Walker River Reservation. Wells may need to be drilled or water may need to be transported to the site.

No existing power was observed in the study area. The distance to existing power is unknown.

5.0 FIELD AND LABORATORY TESTING AND RESULTS

To provide an initial characterization of rock properties that were observed and sampled from outcrops at the five sites, the field crew performed one field test and six types of tests were performed in laboratories. Consideration must be given to whether the rock samples taken from these surface outcrops are representative of the rock mass at depth, which would comprise the majority of source rock produced at the quarry. Rock samples taken from cores during future stages of quarry investigation would likely provide more representative characteristics of the source rock for the production ballast.

No one test is sufficient to "make or break" a quarry site, as there are numerous warnings in the technical literature regarding the limitations of the tests for choosing a site for borrow materials. For this reason, several tests were performed, some of which yielded more than one index value, to obtain multiple indicators of a rock's potential performance in the field. All of the test results must be considered in order to evaluate the suitability of a rock to perform as ballast.

5.1 Field Testing

To obtain an estimate of the strength of rock in the field, a Schmidt Hammer was used by the field crew on outcrops. In every case, at least one set of readings was obtained on the outcrop where rock samples were taken. The Schmidt Hammer was developed for testing concrete hardness, but was later adopted as a non-destructive method for estimating the strength of rock in outcrop and cores. Empirical relationships were developed between the hammer readings and uniaxial compressive strength, Young's modulus, and density (Katz et al., 2000).

The readings were taken and tabulated in accordance with American Society for Testing and Materials (ASTM) C 805-79, Rebound Number of Hardened Concrete. The readings were converted to uniaxial compressive strength using a relationship presented by Stagg and Zienkiewicz (1968). The results are presented in Table 2. The unit weight of the sampled rock is included in the table, as the compressive strength is dependent on the dry unit weight. Because rock outcrop surfaces are variable in orientation and the Schmidt Hammer is sensitive to the angle at which it strikes the rock, all readings were normalized to vertical for calculation of the strength of the rock in the outcrop.

5.2 Laboratory Testing

Rock samples retrieved in the field were transported to the Ninyo & Moore laboratory in Las Vegas, where sufficient rock was retained to perform two of the tests listed below. The balance of the rock samples were sent to Shannon & Wilson's Seattle office for observation and distribution to the other laboratories. A portion of each sample was retained in Seattle for point load testing. The six laboratory tests performed by five laboratories are:

Bulk Specific Gravity/Absorption	Shannon & Wilson-Fairbanks, Alaska
Degradation (L.A. Abrasion)	Ninyo & Moore-Las Vegas, Nevada
Sulfate Soundness	Ninyo & Moore-Las Vegas, Nevada
Point Load	Shannon & Wilson-Seattle, Washington
Petrographic Analysis	Stevens Exploration Management Corp.-Anchorage, Alaska
Total Free Silica	ALS Chemex-Vancouver, British Columbia

The laboratory test results and an explanation of the tests are presented in Appendix C. Table 1 is a summary of the laboratory test results, including the test method (i.e., ASTM and International System of Units [SI]), and the acceptable AREMA standards for the tests, where applicable. Although not specified as part of the rock evaluation, the petrographic analysis also produced an estimate of the alteration of the rock sample, so it was included in Table 1.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Quarry Site Rating Criteria

Five sites were evaluated for suitability as ballast production sources for the MRC. In order to rate the potential quarry sites, nine criteria were chosen to represent the factors that should be considered important for differentiating the sites:

- Rock quality
- Rock tonnage potential
- Mining encumbrances
- Appurtenant structure space
- Overburden removal
- Length of access road to highway

- Length of access road to railroad
- Potential for inundation/harm
- Ease of exploration

Definitions of these criteria are presented in Appendix D, including an explanation of the range of rating values assigned to each of the criteria.

6.2 Quarry Site Rating System

The assignment of a rating value was based on information in the Quarry Field Evaluation Checklist forms (Appendix A), the summaries of the potential quarry sites in Section 4.3 of this report, and the field (Table 2) and laboratory (Appendix C) test results. Engineering and geologic judgment was also used to assign the score values that are presented in Table 3, Quarry Site Rating Table.

Certain of these factors were considered to be essential and others accessory, so some means of differentiating their importance was necessary. For instance, without suitably hard and durable rock, no quarry site was viable; whereas, a lengthy access road adds cost for site improvements and travel time, but may be accommodated within the budget of the project. Based on the experience of six geotechnical engineers and geologists at Shannon & Wilson, weighting factors were assigned to each of the criteria, as shown in Table 3. Weighing factors ranged from 10 (rock quality) to 1 (ease of exploration). The total weighted score for each potential quarry site was obtained by multiplying the raw score for each criterion by the weighting factor, and then summing the total weighted scores for each category. The total weighed scores ranged from 162 points (Gabbs Range) to 148 points (Weber Dam).

Non-geotechnical considerations, such as archeological, cultural, biological, and water resources would influence the selection of ballast quarry sites. The presence of these resources in the areas of our reconnaissance and the impacts caused by quarry development were beyond our scope of services, and are being evaluated by others.

6.3 Discussion

Five sites were evaluated for their potential to supply ballast to the MRC based on geological, geotechnical and other related factors. They are located in two general geographic areas: two in the south and three in the north (Plate 1). The areal distribution of ballast supply sites will be determined by others as design of the project progresses.

Of the nine criteria that contributed to the rating of the quarries (Table 3), only two are of ultimate importance in selecting a quarry site for ballast. These are reflected in the weighting factors in Table 3. For a hard rock quarry, it is absolutely necessary that the rock is of high quality. Without hard, durable rock, the quarry would be a failure, and the rail line would incur difficulties with alignment and grade in the future. Because preliminary visits were made to each of the five sites by one or two teams during the initial geologic reconnaissance phase and the five sites were selected for the final group of potential quarry site partly based on their rock quality characteristics, it is not unexpected that all of the sites scored the highest possible value in rock quality.

Regarding quantity, multiple (and smaller) hard rock pits could be developed without sufficient tonnage to supply all or a large section of the alignment; however, because of the expense of opening and decommissioning a quarry (S&W, 2005a), it is more economical to operate fewer quarries that have proven reserve to fulfill their purpose. Because preliminary visits were made to each of the five sites by one or two teams during the initial geologic reconnaissance phase and the sites were selected for the final group of potential quarry site partly based on their potential to produce ample rock quantity, it is not unexpected that all of the sites scored the highest value in rock quantity. In a similar vein, overburden thickness is suitable and obtains maximum score for every site.

6.3.1 Southern Quarries

In the Goldfield area, both quarry sites (Malpais Mesa South and North Clayton) performed well in laboratory testing for this study and the porphyritic basalt and granite, respectively, appeared good in outcrop. Both had some encumbrances that would have minor impact on their development. At Malpais Mesa South, the top rim of the mesa has been claimed for surface installation of wind turbines in a portion of the area proposed for ballast quarrying. Also, mining claims in the flats to the south of the mesa force the location of siding and loading facilities to the east of a closer, more direct location of the conveyor.

At North Clayton, mineral claims exist in close proximity to, but not within, the proposed ballast quarrying area. The claims appear to be associated with the westernmost edge of the targeted pluton and two smaller dikes to its west.

Both prospective quarry sites are distant from US 95. The terrain of the road access to Malpais Mesa South is steep and winding; so although it is feasible, it will be more expensive to build access to the quarry and its appurtenant facilities than the other quarry sites on the MRC. North Clayton has the advantage of being immediately adjacent to the MN1 route, whereas Malpais Mesa South is about 2 miles distant and requires delivery from the quarry to the processing plant by a conveyor system. The processing and siding facilities at Malpais Mesa South could also be accessed by a spur north from an existing road; separate from the access to the quarry site.

Malpais Mesa South is the easiest of the quarry sites to explore because it has a relatively flat top, such that a track-mounted drill rig could easily drive to all exploration holes or a truck-mounted drill rig could reach the drilling locations with minor dozer preparations. Topography at North Clayton would require pioneer roads, track-mounted equipment and perhaps, dozer assistance.

We recommend that both of these sites be considered for use as a hard rock ballast quarry site at the southern end of the MRC.

6.3.2 Northern Quarries

The granite, basalt and granite at Gabbs Range, Garfield Hills and Weber Dam, respectively, met all of the AREMA standards for ballast, were of high strength, and contained little to no alteration.

None of the three prospective quarry sites had mining encumbrances; however, access for operations would have to be closely coordinated and permission granted from the U.S. Army for roads and the siding at Garfield Hills and for all activities from the Walker River Tribe for Weber Dam.

At the Gabbs Range and Garfield Hills sites, hydrologic studies would be needed and protective berms and/or culverts would have to be installed, because active dry washes could negatively impact quarry mining and processing.

For geotechnical explorations, Gabbs Range and Garfield Hills would require tracked drilling equipment, and would likely need some dozer roads and assistance. At the Weber Dam quarry site, the topographic conditions are severe, so it is likely that some locations would a require helicopter lift, in addition to those locations that need dozer roads and assistance.

We recommend that these three sites be considered for use as a hard rock ballast quarry site at the northern end of the MRC.

6.4 Recommendations for Future Geologic/Geotechnical Studies

Once quarry sites are chosen for a next stage of evaluation, we recommend that additional geologic/geotechnical studies be undertaken to learn more about the rock deposits in the quarry sites. Such studies should include detailed outcrop mapping, selection of specific drilling locations, exploratory core drilling, laboratory testing of the cores retrieved from the borings, and geophysical explorations to correlate conditions between borings, if necessary.

The first stage of subsurface explorations at the potential quarry sites should consist of 9 to 14 borings in locations that might best represent the geologic conditions and anticipated quarry configuration. Borings should be extended to about 20 feet below the lowest expected floor level of the pit. When the final one or more sites are chosen for the quarry site, a patterned grid of core borings should then be drilled to obtain detailed information for quarry design and a mining plan.

SHANNON & WILSON, INC.

PROFESSIONAL ENGINEER-STATE OF NEVADA
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Task 2 Manager

DEX:PMG:WTL/wtl

REFERENCES

Albers, J.P., and Stewart, J.H., 1972, Geology and mineral deposits of Esmeralda County, Nevada: Nevada Bureau of Mines and Geology Bulletin 78, 80 p.

American Railway Engineering and Maintenance-of-Way Association (AREMA), 2007, Manual for railway engineering: Landover, Md., American Railway Engineering and Maintenance-of-Way Association, 4 v.

American Society for Testing and Materials (ASTM), 2007, Annual book of ASTM standards, West Conshohocken, Penn., 77 v.

Barksdale, R.D., 1991, The aggregate handbook: Washington, D.C., National Stone Association, 1 v.

Bonham, H.F., and Garside, L.J., 1979, Geology of the Tonopah, Lone Mountain, Klondike, and Northern Mud Lake quadrangles, Nevada: Nevada Bureau of Mines and Geology Bulletin 92, 142 p., 2 plates.

Caterpillar, 2006, Caterpillar performance handbook, (36^{th} ed.): Peoria, Ill., Caterpillar, 1 v.

Church, H.K., 1981, Excavation handbook: N. Y., McGraw-Hill, 1 v.

Katz, O., Reches, Z., and Roegiers, J.-C., 2000, Evaluation of mechanical rock properties using a Schmidt Hammer: International Journal of Rock Mechanics and Mining Sciences, v. 37, no. 4, p. 723-728.

Moore, J. G., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 75, 45 p., 1 map.

Nevada Rail Partners, 2007, Question on text on cuts along the Mina Corridor: personal communications (email) from Tony Niemeyer, Nevada Rail Partners, Las Vegas, Nev., to Kathy Mrotek, BSC, Las Vegas, Nev., 28 March.

Oriard, L.L., 2002, Explosives engineering, construction vibrations and geotechnology: Cleveland, Ohio, International Society of Explosives Engineers, 685 p.

Roggensack, K., and Sargent, K.A., 1984, Map showing outcrops of basaltic rocks of early Quaternary and Tertiary Age, Basin and Range Province, Nevada: U.S. Geological Survey, Water Resources Investigation Report 83-4119-F, scale 1:500,000.

Ross, D. C., 1961, Geology and mineral deposits of Mineral County, Nevada: Nevada Bureau of Mines and Geology Bulletin 58, 98 p, 10 plates.

Shannon & Wilson, Inc., 2005a, Ballast sourcing cost analysis, phase 1, Caliente rail corridor, Yucca Mountain project, Nevada, submittal no. 7.4, rev. 0: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-20102-022, for BSC, Las Vegas, Nev., February 18.

Shannon & Wilson, Inc., 2005b, Preliminary geotechnical design criteria manual, phase 1, Caliente rail corridor, Yucca Mountain project, Nevada, submittal no. 7.1, rev. 0: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-20102-013, for BSC, Las Vegas, Nev., February 24.

Shannon & Wilson, Inc., 2006a, Preliminary construction aggregate report, Caliente rail corridor, Yucca Mountain project, Nevada, submittal no. 8.10, rev. 1: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-20102-112, for BSC, Las Vegas, Nev., March 7.

Shannon & Wilson, Inc., 2006b, Ballast quarry report, Caliente rail corridor, Yucca Mountain project, Nevada, submittal no. 8.6, rev. 0: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-20102-108, for BSC, Las Vegas, Nev., March 8.

Stagg, K.G.. and Zienkiewicz, O.C., 1968, Rock mechanics in engineering practice: N. Y., John Wiley & Sons, 442 p.

U.S. Federal Highway Administration, 2005, Federal lands highway project development and design manual: U.S. Federal Highway Administration Report no. FHWA-DF-88-003, 1 v.

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

TEST	TEST METHOD	AREMA STANDARD	MALPAIS MESA SOUTH	NORTH CLAYTON	GABBS RANGE	GARFIELD HILLS	WEBER DAM
Bulk Specific Gravity	ASTM C 127	>2.60	2.75	2.63	2.61	2.78	2.60
Absorption (Percent)	ASTM C 127	<1.0%	0.7	0.3	0.4	0.5	0.2
Degradation (Percent)	ASTM C535	<25% traprock <35% granite	18	32	21	14	16
Sulfate Soundness (Sodium Sulfate) 5 cycles (percent)	ASTM C 88	<5.0%	1.3	1.5	1.2	1.3	0.4
Point Load (psi)	ASTM D5731-02	NA	26,400	21,700	18,700	27,400	30,300
Petrographic Analysis		NA	Porphyritic Leucobasalt	Granite	Granite	Basalt	Granite
Total Free Silica (percent)	SI ICP 81	NA	22.5	33.5	34.2	23	36.1
Alteration (percent)		NA	5	Negligible	Negligible	Negligible	Negligible

NOTES:
(1) Materials having gradations containing particles retained on the 1-inch seive were tested by ASTM D 535.
(2) Point load test ASTM D5731-02 is also known as ISRM RTH 325-80.

ASTM: American Society for Testing and Materials
ICP: Inductively Coupled Plasma spectrometer
ISRM: International Society of Rock Mechanics
SI: International System of Units

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TABLE 2
SCHMIDT HAMMER RESULTS

QUARRY	LOCATION	DRY UNIT WEIGHT (pcf)	AVERAGE FIELD READING	CALCULATED UNCONFINED COMPRESSIVE STRENGTH (psi)
Malpais Mesa South	Goldfield	172	41	14,000
North Clayton	Montezuma Range	164	53	23,000
Gabbs Range	Gabbs Range	163	58	31,500
Garfield Hills	Garfield Hills	173	50	24,000
Weber Dam	White Mountain	162	60	33,000

NOTES:

(1) Schmidt Hammer model L

(2) Calculation method per ASTM C805

pcf: pounds per cubic foot

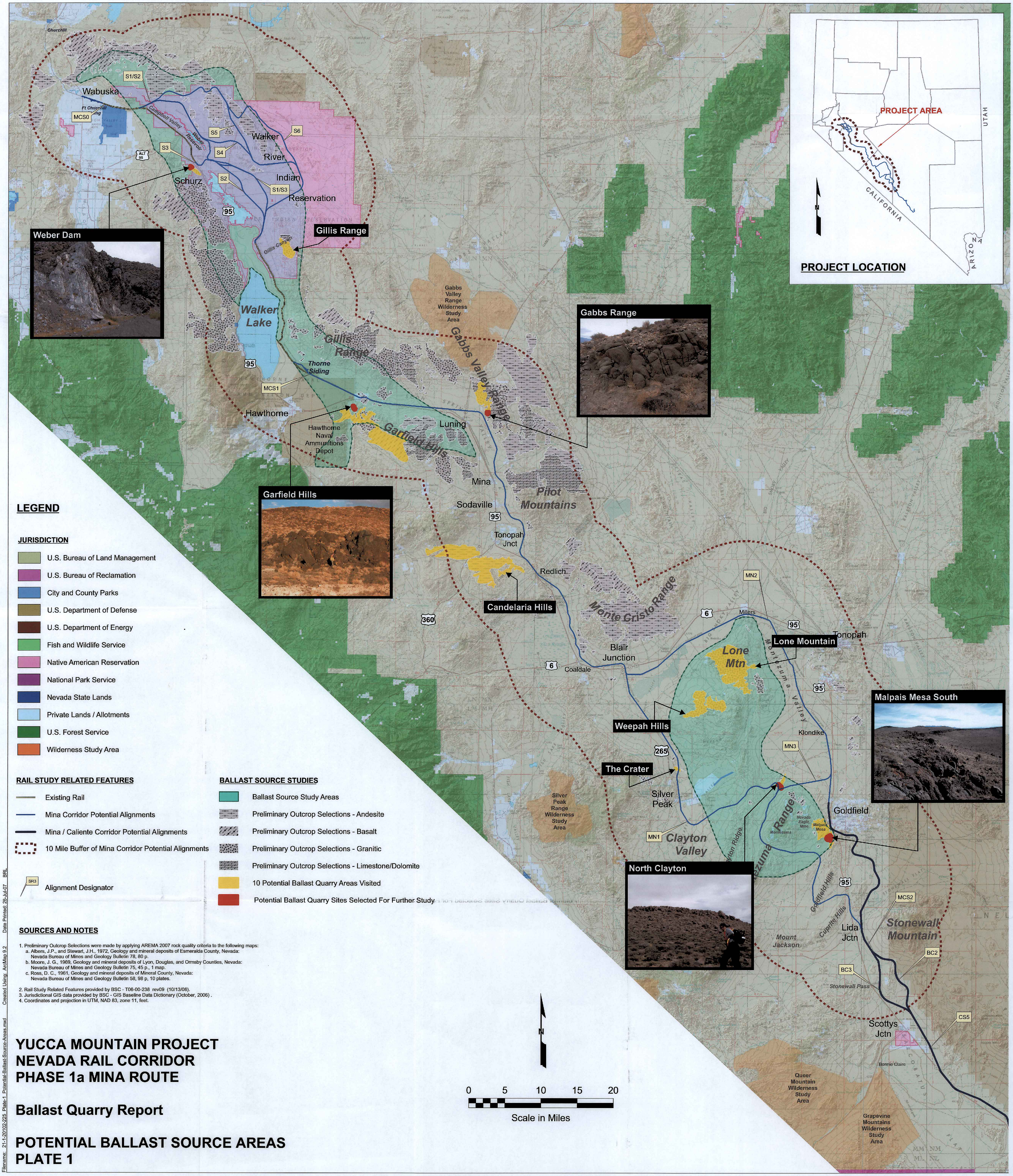
psi: pounds per square inch

UCS: Unconfined compressive strength

TABLE 3
QUARRY SITE RATING TABLE

CRITERIA	WEIGHTING FACTOR	RAW SCORE FOR EACH QUARRY SITE [5 (HIGH) TO 1 (LOW)]				
		MALPAIS MESA SOUTH	*NORTH CLAYTON*	*GABBS RANGE*	*GARFIELD HILLS*	*WEBER DAM*
Rock Quality	10	5	5	5	5	5
Rock Tonnage Potential	6	5	5	5	5	5
Mining Encumbrances	4	3	3	5	3	3
Appurtenant Structure Space	3	4	5	5	5	4
Overburden Removal	3	5	5	5	5	5
Length of Access Road to Highway	3	3	2	3	3	4
Length of Access Road to Railroad (RR)	3	3	5	5	4	4
Potential for Inundation/Harm	2	4	4	2	2	2
Ease of Exploration	1	5	3	4	4	1
	Total Weighted Score:	**150**	**154**	**162**	**151**	**148**

NOTES:
(1) Archaeological, cultural, biological, and water supply resources are being evaluated by others.
(2) The definitions for quarry rating criteria are presented in Appendix D.



PROJECT AREA
UTAH
CALIFORNIA
ARIZONA
PROJECT LOCATION
Weber Dam
Gillis Range
Gabbs Range
Garfield Hills
Candelaria Hills
Lone Mountain
Weepah Hills
The Crater
Malpais Mesa South
North Clayton
Churchill
Wabuska
Ft Churchill
MCS0
S1/S2
S3
S4
S5
S6
S2
S1/S3
MCS1
MN1
MN2
MN3
MCS2
BC2
BC3
CS5
Schurz
Walker River Indian Reservation
Walker Lake
Gillis Canyon
Gabbs Valley Range Wilderness Study Area
Gabbs Valley Range
Thorne Siding
Hawthorne
Hawthorne Naval Ammunitions Depot
Luning
Mina
Sodaville
Pilot Mountains
Tonopah Jnct
Redlich
Monte Cristo Range
Millers
Tonopah
Blair Junction
Coaldale
Lone Mtn
Montezuma Valley
Klondike
Silver Peak
Silver Peak Range Wilderness Study Area
Clayton Valley
Goldfield
Malpais Mesa
Lida Jctn
Stonewall Mountain
Mount Jackson
Stonewall Pass
Scottys Jctn
Bonnie Claire
Queer Mountain Wilderness Study Area
Grapevine Mountains Wilderness Study Area
95
6
265
360
LEGEND
JURISDICTION
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
City and County Parks
U.S. Department of Defense
U.S. Department of Energy
Fish and Wildlife Service
Native American Reservation
National Park Service
Nevada State Lands
Private Lands / Allotments
U.S. Forest Service
Wilderness Study Area
RAIL STUDY RELATED FEATURES
Existing Rail
Mina Corridor Potential Alignments
Mina / Caliente Corridor Potential Alignments
10 Mile Buffer of Mina Corridor Potential Alignments
SR3
Alignment Designator
BALLAST SOURCE STUDIES
Ballast Source Study Areas
Preliminary Outcrop Selections - Andesite
Preliminary Outcrop Selections - Basalt
Preliminary Outcrop Selections - Granitic
Preliminary Outcrop Selections - Limestone/Dolomite
10 Potential Ballast Quarry Areas Visited
Potential Ballast Quarry Sites Selected For Further Study
SOURCES AND NOTES
1. Preliminary Outcrop Selections were made by applying AREMA 2007 rock quality criteria to the following maps:
a. Albers, J.P., and Stewart, J.H., 1972, Geology and mineral deposits of Esmeralda County, Nevada: Nevada Bureau of Mines and Geology Bulletin 78, 80 p.
b. Moore, J. G., 1969, Geology and mineral deposits of Lyon, Douglas, and Ormsby Counties, Nevada: Nevada Bureau of Mines and Geology Bulletin 75, 45 p., 1 map.
c. Ross, D. C., 1961, Geology and mineral deposits of Mineral County, Nevada: Nevada Bureau of Mines and Geology Bulletin 58, 98 p, 10 plates.
2. Rail Study Related Features provided by BSC - T06-00-238 rev09 (10/13/06).
3. Jurisdictional GIS data provided by BSC - GIS Baseline Data Dictionary (October, 2006) .
4. Coordinates and projection in UTM, NAD 83, zone 11, feet.
YUCCA MOUNTAIN PROJECT
NEVADA RAIL CORRIDOR
PHASE 1a MINA ROUTE
Ballast Quarry Report
POTENTIAL BALLAST SOURCE AREAS
PLATE 1
0 5 10 15 20
Scale in Miles
N
Filename: 21-1-20102-225_Plate-1_Potential-Ballast-Source-Areas.mxd Created Using: ArcMap 9.2 Date Printed: 26-Jul-07 BRL

APPENDIX A

QUARRY FIELD EVALUATION CHECKLISTS

APPENDIX A

QUARRY FIELD EVALUATION CHECKLISTS

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LIST OF SUBAPPENDICES

Subappendix

QUARRY FIELD EVALUATION CHECKLIST

Quarry Designation: MALPAIS MESA SOUTH
Field Team: Keith Rauch, Elizabeth Karcheski
October 28 and 29, 2006

1. SITE FEATURES (show on map to the extent possible)

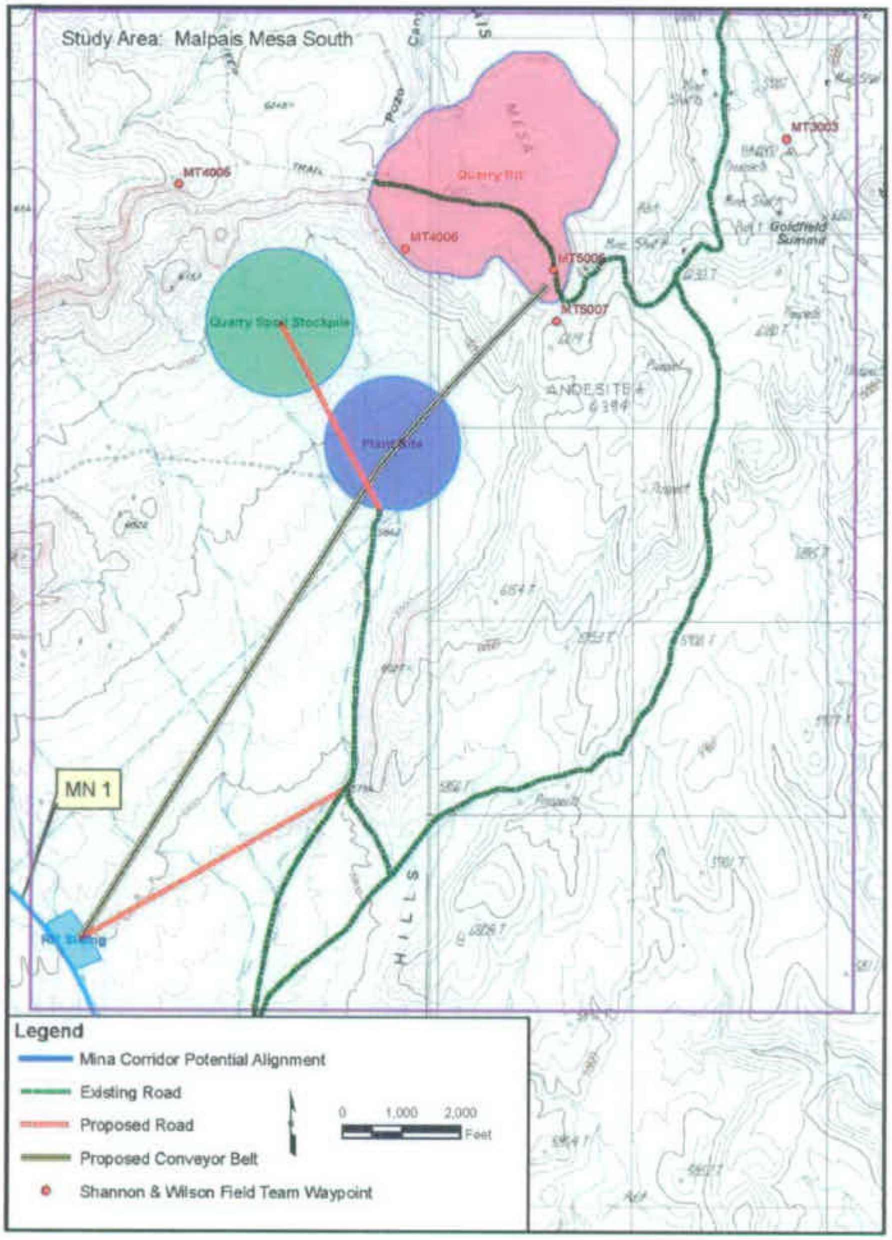


Figure A.1-1. Malpais Mesa South Ballast Quarry Conceptual Layout

A. Topography

Malpais Mesa consists of multiple basalt flows with interbedded multiple layers of ash tuff. The mesa is about 4 miles long (northwest to southeast) and 2 miles wide (southwest to northeast). The top of the mesa is generally flat with locally steep relief. The study area is at the south end of the mesa, where basalt flows with interbedded tuffs form a steep 200-foot-high, bowl-shaped cliff or steep slope (Figure A.1-1). This bowl opens to the southwest onto a broad alluvial fan that slopes gently down to the south. Slopes on the edge of the mesa average about 32 degrees. Slopes on the fan are 1 to 2 percent.

B. Surface Water (near stream/river?), what flow?, intermittent)

The alluvial fan between the quarry site and its railroad connection contains three dry washes, which may flow during major rain events. All the washes flow in a southerly direction.

C. Room for Plant/Office Facilities (need 80 acres of flat land)

There is adequate acreage available for a plant facility on the alluvial fan southwest of the quarry site. Slopes in this area average 1 to 2 percent. Only minor cuts and fills will be required. Sandy gravel and gravelly sand can be removed by conventional methods for site development.

D. Existing Access roads (where are they? can they be improved? show on maps)

We reached the site using a jeep trail that leaves highway US 95 at N37.68915°, W117.23318°. Table A.1-1 lists the approximate distances from US 95.

TABLE A.1-1
APPROXIMATE DISTANCES TO SITE LOCATIONS BY EXISTING UNPAVED ROADS

Location	Distance (miles)
Proposed quarry site	2.3
Proposed plant site	4.8
Proposed spoil stockpile	5.5
Proposed railroad siding	4.7

These are narrow, unpaved, dirt trails that are adequate for exploration drill rigs during dry weather. They will need improvement to serve as access roads to an active quarry site. The Malpais Mesa South site map (Figure A.1-1) shows the jeep trails and where new roads are needed to access the proposed quarry spoil stockpile area and railroad siding.

An alternate access to the processing and transport facilities could be from the south via Railroad Springs Road and about 0.4 mile of new roadway. Railroad Springs Road is a well-maintained dirt road.

E. Room for Railroad Siding (where would siding be for loading ballast cars?)

The proposed MN-1 alignment lies 2.4 miles southwest of the proposed quarry pit. There is adequate room for a 10-acre (or larger) siding facility adjacent to the tracks at N37.65200°, W117.27426°. Some preliminary construction estimates are listed in Table A.1-2.

TABLE A.1-2
PROPOSED RAILROAD SIDING – SITE CHARACTERISTICS

Item	Value
Average site elevation	5,810 ft
Average slope	2 percent
New roads	1.0 mi
Improved roads	3.7 mi

Most of the cut material could be used to fill and level the lower side of the site. The site lies on an alluvial fan composed of silty, gravelly sand and silty, sandy gravel. This material can be removed using conventional excavation methods.

F. Room for Spoil Stockpile (need ~flat to ~gently sloping topo)

Figure A.1-1 shows the proposed spoil stockpile site of about 111 acres. It is located adjacent to the proposed plant site to minimize new road construction. No earthwork will be required to prepare the site. Some preliminary construction estimates are listed in Table A.1-3.

TABLE A.1-3
PROPOSED QUARRY SPOIL STOCKPILE – PRELIMINARY SITE CHARACTERISTICS

Item	Value
Average site elevation	5,970 feet
Average slope	4 percent
New roads	0.7 mile
Improved roads	None

G. Access Roads (to highway and RR alignment)

All-weather access to the site would require construction of 6 miles of improvements to existing jeep trails and 1 mile of new roads. Some preliminary road construction estimates are listed in Table A.1-4.

TABLE A.1-4
PRELIMINARY ROAD CONSTRUCTION ESTIMATES

From	To	Improved (mi)	New (mi)	Avg. Percent Slope	Max Percent Slope
US 95	Quarry	2.3	0.0	4	16
Quarry	Plant	3.7	0.0	3	14
Plant	Spoil Pile	0.0	0.7	2	4
Plant	Siding	0.0	1.0	1	3
TOTALS		6.0	1.7		

i. Topographic conditions for new roads

The 2.3-mile jeep trail between US 95 and the quarry becomes steep and winding on the side slope of the mesa (see Table A.1-4). We anticipate, however, that most of the traffic on this road will be light 4WD vehicles with only occasional trips by large, heavy construction equipment. Similar traffic patterns on the 3.7-mile quarry-to-plant road lead us to believe that the existing trail can be upgraded rather than replaced by a new road.

The new 0.7-mile plant-to-spoil stockpile road will be used primarily by loaded dump trucks and heavy construction equipment. It will need to be built to support this traffic under all weather conditions. The gentle slopes on this proposed route will require no significant earthwork during construction.

The new 1-mile plant-to-siding road will be used primarily by light 4WD vehicles, with only occasional trips by heavy construction equipment. The gentle slopes on this proposed route will not require significant earthwork during construction.

As noted in Section 1.0 above, access roads from the south along Railroad Springs Road would be very low gradient and require minimal earthwork to the processing and loading facilities.

ii. Cut slopes (soil/rock)

Existing topographic conditions and anticipated traffic patterns lead us to expect that no significant soil or rock cuts will be required during road construction at this site. See discussion in the previous section.

2. DEPOSIT FEATURES

A. Location (show on 1:24,000 scale topo to the extent possible; record T, R, Sec)

The 258-acre quarry pit (Figure A.1-1) is located in the SW/4 sec 15, T 3 S, R 42 E (Esmeralda County, Nevada, Mt. Diablo Meridian).

Malpais Mesa was evaluated for a ballast quarry site in 2005 for the Caliente Route. A site was selected at the north end of this expansive mesa where it is in relative proximity to the Caliente

Route. For the Mina Route studies, the mesa was again evaluated, but for a site closer to the MN-1 route. This potential ballast quarry site was designated Malpais Mesa South to distinguish it from the site at the north end of the mesa.

B. Tonnage (provided in this deposit [W x L x H])

Outcrops observed in the study area indicate that the proposed quarry pit will support a multiple-bench operation covering about 258 acres with a pit floor at the base of the andesite flows (estimated 6200 elevation). The thickness averages about 70 feet. Quarrying would begin along the southern cliff face and advance to the north. A quarry pit of these dimensions can produce roughly 13.1 million total tons of unprocessed stone.

C. Overburden (note thickness/type)

Surface observations suggest that the proposed quarry pit area is covered with 0 to 5 feet of residual sandy gravel overburden. Actual depths need to be confirmed with borings and/or test pits. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

D. Deposit Features

i. Rock Type/Description (use S&W rock descriptions)

The rock unit of interest in the proposed quarry pit is <u>BASALT,</u> a dark, fine-grained extrusive igneous rock that forms at, or near, the surface as volcanic lava flows and shallow intrusions. It generally cools quickly and has a glassy to very fine-grained crystalline texture. It commonly contains small spherical voids (vesicles) formed by the expansion of gas or steam during cooling. The vesicles are normally more numerous near the top of a basalt flow.

Basalt consists mostly of plagioclase feldspar with olivine, magnetite, pyroxene, biotite and iddingsite. The vesicles observed in this outcrop are most often filled with zeolite crystals.

We observed three rock types in the sample outcrop area:

A. <u>Basalt</u>: moderate to medium strength, gray, fine crystalline; massive, highly vesicular with approximately 90 percent zeolite-filled vesicles, jointed; fresh to slightly weathered.
B. <u>Basalt</u>: moderate to medium strength, gray, fine crystalline; massive, highly vesicular with approximately 10 percent zeolite-filled vesicles, jointed; fresh to slightly weathered.
C. <u>Tuff</u>: low to moderate strength, red, porphyritic; massive, lineated; slightly weathered. Not suitable ballast material and not sampled for this study.

ii. Thickness/Depth (need minable thickness)

Two separate lava flows are visible in the cliff face outcrops. The lower flow is about 30 feet thick. The top of the upper flow is not fully exposed but may be as thick as 40 feet. The two flows together may have a minable thickness of about 70 feet.

iii. Rock Structure (block sizes/joint or fracture spacing)

a. Joints and Fractures

All joints are steeply dipping at 2- to 5-foot spacing. Joint faces are fairly smooth and open (not cemented). Joint measurements are presented in Table A.1-5.

TABLE A.1-5
JOINT MEASUREMENTS AT SAMPLED OUTCROP

Outcrop Number	Lithology Type	Dip Angle° (degrees)	Dip Direction (Azimuth)
2	A	75	294
2	A	80	305
2	A	75	010
3	A	79	036
3	A	85	155
4	B	82	173
4	B	69	190
5	A	87	273
5	A	90	254
6	A	83	011
6	A	73	115
7	C	67	164
7	C	82	220

b. Estimated block size distribution

Block size distribution is presented in Table A.1-6.

TABLE A.1-6
ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	10 percent
4.0 – 6.0 ft	40 percent
2.0 – 4.0 ft	30 percent
0.5 – 2.0 ft	15 percent
< 0.5 ft	5 percent

It reflects the jointing spacing measured at various locations on the outcrop.

c. Deleterious Materials, including orientation and thickness (Note: Ash layers/faults/weather contacts, shear zones, fillings, scoriaceous zones, rubble zones, etc. This is internal waste that reduces deposit size.)

Field observations suggest that up to 25 percent of the rock in the quarry pit consists of altered or rubble/scoriaceous zones between flows. This material is not suitable for ballast but cannot be avoided during quarrying.

d. Rock Quality Designation (RQD)

RQD of the sampled outcrop is estimated to be 80 to 90 percent. This reflects the vertical jointing and generally massive nature of the outcrop.

e. Samples for testing (100 pounds minimum; describe sample; taken)

On 29 October 2006, roughly 200 lbs of rock samples were collected at waypoint MT4006 (Figure A.1-1), at about 6,230 feet elevation; six canvas sample bags were filled.

f. Rock hammer test

The basalt sampled for this study typically fractures with one to five blows from a standard geologic rock hammer, indicating moderate to medium strength.

g. Schmidt-hammer tests

Ten Schmidt-hammer field tests were performed at the sample collection site. Test results are presented in Table A.1-7. In all tests, the instrument was oriented perpendicular to the rock surface. Two tuff outcrops were tested (tests 9 and 10) for comparison to the andesite.

TABLE A.1-7
MALPAIS MESA SOUTH SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Lithology	Test Surface Dip/Dip Drection
1	40	A	79/060
2	45	A	75/294
3	40	A	30/010
4	46	A	79/036
5	54	B	69/190
6	28	B	82/173
7	44	A	90/254
8	55	A	83/011
9	45	C	82/220
10	32	C	67/154

iv. Groundwater — Is there evidence of groundwater near the surface? Want to avoid groundwater in pit as this causes permitting problem.

We saw no evidence of groundwater in the study area. We do not anticipate groundwater inflow into the quarry pit during quarry operations. Seasonal surface water inflow should be minimal.

E. Future Explorations

Core drilling is recommended to recover subsurface samples and to characterize the quality of the basalt within the proposed quarry pit. A minimum of 13 borings are recommended during the preliminary phase of exploration.

a. Drill rig access

The existing narrow dirt trails are adequate for exploration drill rigs during dry weather or dry road conditions.

b. Type of rig

The existing trails and gentle slopes in the quarry pit area can be negotiated using a 4WD truck-mounted rock coring rig.

c. Approximate depths and total footage of borings

We propose a final quarry floor elevation of 6,200 feet. Each boring should bottom 10 feet below this elevation, or 6,190 feet. These depths range from 27 feet at the northwestern edge of the quarry to 90 feet at the highest point on the mesa. The total estimate of required coring would be about 1,000 feet. If these cores indicate that the lower andesite flow has an irregular base, additional coring may be needed to evaluate the quarry pit area.

d. Geophysics alignments

The Malpais Mesa South site has good outcrop exposures and easy drill access; however, the variable nature of basalt flows in this region may be reason to perform a few to several geophysical lines between borings after rock coring.

3. ENVIRONMENTAL FEATURES

A. Vegetation (what type/how much/where)

Vegetation consists mainly of sage, desert grasses, and sparsely scattered Joshua trees, with about 10 to 15 percent ground cover.

B. Visibility (would quarry be visible from road?)

The proposed quarry site would be visible from Railroad Springs Road, an east-west dirt road that crosses the M1 alignment about 3.6 miles south of the proposed quarry site (N37.63188°, W117.27090°). The quarry would not be visible from highway US 95, located about 0.5 mile to the east.

4. OTHER FEATURES

A. Power (is power nearby or need on-site generation)

There are no existing power lines within the study area. The closest known power line is approximately 1.3 miles to the east at US 95.

B. Water (groundwater studies by others)

No visible wells or springs were observed within the study area. An abandoned aqueduct is present within the study area. It begins near the base of the mesa and trends to the southwest. The aqueduct pipe has multiple breaks and is partially filled with sand. The source of water for this aqueduct appears to have dried up long ago. Wells may need to be drilled to supply water to the site.

5. MALPAIS MESA SOUTH PHOTOS

MT4006_BKR_0161_28Oct06: Malpais Mesa South. Outcropping basalt flows at sample location; looking E.

MT4006_BKR_0162_28Oct06: Malpais Mesa South. Outcropping basalt flows at sample location; looking W.

MT4006_BKR_0163_28Oct06: Malpais Mesa South. Top of Malpais Mesa, looking S toward Railroad Springs Road and alignment.

QUARRY FIELD EVALUATION CHECKLIST

Quarry Designation: NORTH CLAYTON
Field Team: Keith Rauch, Elizabeth Karcheski
October 30, 2006

1. SITE FEATURES (show on map to the extent possible)

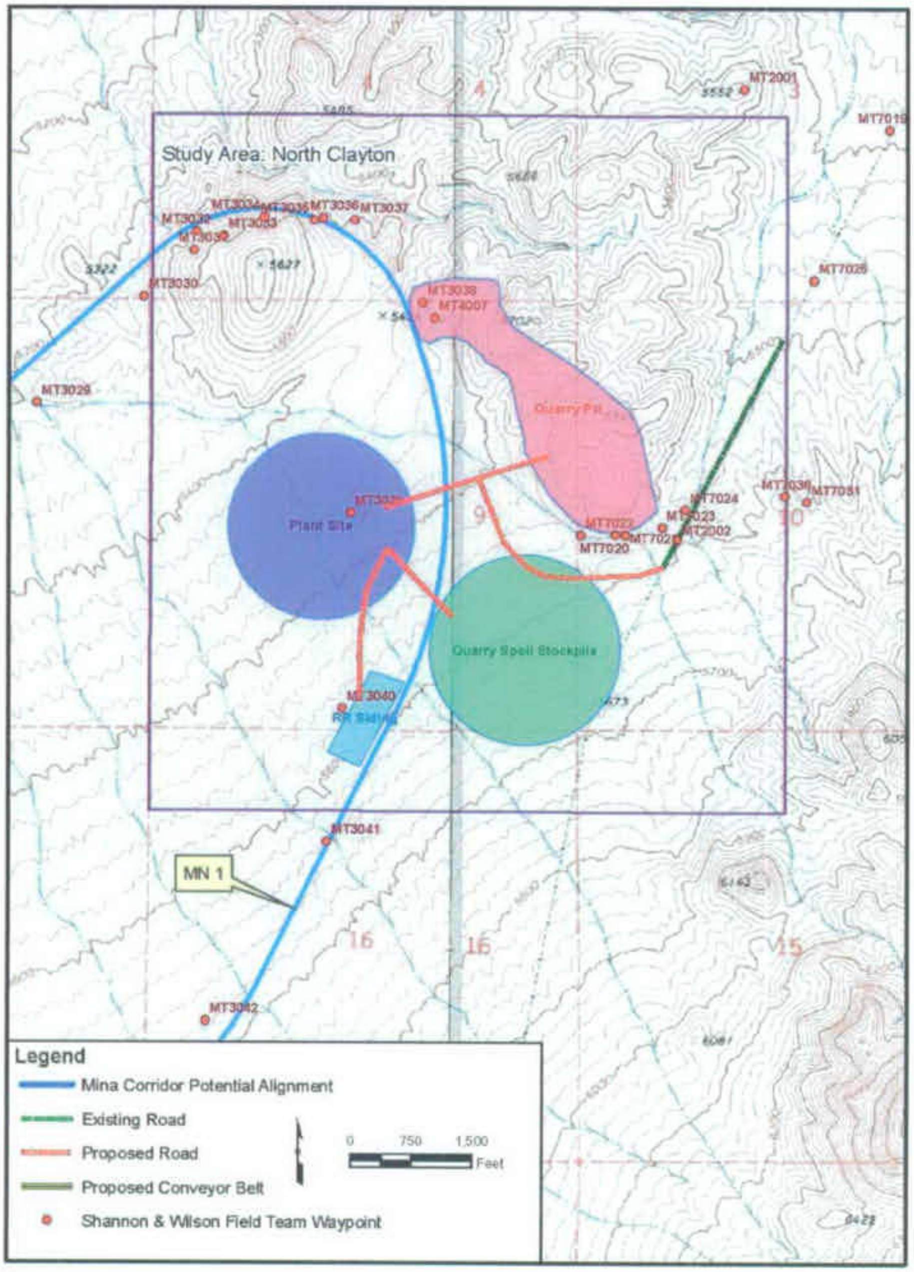


Figure A.2-1. North Clayton Ballast Quarry Conceptual Layout

A. Topography

Topography in the North Clayton study area is dominated by a northeast-trending ridge. Slopes across the study area are moderate to steep. The topography on alluvial fans to the south and east of the study area slopes northwest and north, respectively, at about 4 percent. Areas to the north and west are rougher, with hills and ridges sloping between 5 and 20 percent.

B. Surface Water (near stream/river?), what flow?, intermittent)

Several dry washes cross the alluvial fan in the south half of the study area. These washes may carry significant water flows during major rain events.

C. Room for Plant/Office Facilities (need 80 acres of flat land)

There is adequate acreage available for a plant facility on the alluvial fan southwest of the quarry site. The proposed plant site encompasses about 96 acres. The surface slopes downward away from the alignment at 3 percent average gradient. The spoil stockpile area could serve as a borrow pit for this fill during construction of the plant facilities. The sandy gravels and gravelly sand in the spoil stockpile area can be removed by conventional methods.

D. Existing Access roads (where are they?, can they be improved? show on maps)

Access to the study area is by way of an existing jeep trail adjacent to a power line that originates at Alkali (N37.82430°, W117.33540°), runs southwesterly for a distance of 6.3 miles then terminates at a rural road (N37.74033°, W117.37811°). The quarry site is west of this road and about 3.5 mi southwest of Alkali. The sample site (MT4007) is located about 1 mile northwest of the dirt road and is accessed by an unmapped jeep trail. The average slope on these trails is about 3 percent with a maximum grade of 7 percent.

These narrow dirt trails are adequate for exploration drill rigs during dry weather. They will need improvement to serve as access roads to an active quarry site. The North Clayton site map (Figure A.2-1) shows existing trails and indicates where new roads are needed to access the proposed quarry, plant site, spoil stockpile, and railroad siding.

E. Room for Railroad Siding (where would siding be for loading ballast cars?)

The proposed MN-1 alignment passes very close to the proposed quarry pit. A better location for the siding, however, is about 0.6 mile southwest of the quarry. Here, there is adequate room for an approximately 11-acre (or larger) siding facility adjacent to the tracks at approximately N37.77513°, W117.38133°. The proposed siding lies topographically below the rail alignment. Some preliminary siding characteristics are listed in Table A.2-1.

TABLE A.2-1
PROPOSED RAILROAD SIDING – CHARACTERISTICS

Item	Value
Average site elevation (ft)	5,590
Average slope (percent)	5
New roads (mi)	1.3
Improved roads (mi)	3.6

F. Room for Spoil Stockpile (need ~flat to ~gently sloping topo)

Figure A.2-1 shows the proposed 99-acre spoil stockpile site. It is located adjacent to the proposed plant site to minimize new road construction. No earthwork is required to prepare the site. The spoil stockpile area lies on an alluvial fan composed of gravelly, silty sand and silty, gravelly sand. This material can be removed using conventional excavation methods.

Some preliminary spoil stockpile characteristics are provided in Table A.2-2.

TABLE A.2-2
PROPOSED QUARRY SPOIL STOCKPILE

Item	Value
Average site elevation (ft)	5,997
Average slope (percent)	6
New roads (mi)	1.6
Improved roads (mi)	3.4

G. Access Roads (to highway and RR alignment)

All-weather access to the site will require construction of 3.4 miles of improvements to existing jeep trails and 1.6 miles of new roads. Some preliminary road construction estimates are listed in Table A.2-3.

TABLE A.2-3
PRELIMINARY ROAD CONSTRUCTION ESTIMATES

From	To	Improved (mi)	New (mi)	Avg. Percent Slope	Max Percent Slope
Alkali	Turnoff	3.4	0.0	3	7
Turnoff	Quarry	0.0	1.0	2	6
Quarry	Siding	0.0	0.6	2	5
TOTALS		3.4	1.6		

i. Topographic conditions for new roads

The 3.4-mile jeep trail between Alkali and the quarry turnoff is easily negotiable by 4WD vehicles during dry periods, but will require improvements to provide all-weather access. Minor fill with culverts may be required in a few locations, but no road cuts or major fills are anticipated.

The new 1-mile turnoff-to-quarry road will be used primarily by loaded dump trucks and heavy construction equipment. It will need to be built to support this traffic under all weather conditions. The gentle slopes on this proposed route will not require significant earthwork during construction.

The new 0.6-mile quarry-to-siding road also provides access to the plant site. It, too, will be used primarily by loaded dump trucks and heavy construction equipment. The gentle slopes on this proposed route will not require significant earthwork during construction.

ii. Cut slopes (soil/rock)

Existing topographic conditions and anticipated traffic patterns are such that no significant soil or rock cuts will be required during road construction at this site. See discussion in the previous section.

2. DEPOSIT FEATURES

A. Location (show on 1:24,000 scale topo to the extent possible; record T, R, Sec)

The 1550-acre study area (Figure A.2-1) is located in the NW/4 sec 10, T 2 S, R 41 E (Esmeralda County, Nevada, Mt. Diablo Meridian).

B. Tonnage (provided in this deposit [W x L x H])

Outcrops observed in the study area indicate that the proposed quarry pit will support a multiple-bench operation covering about 86 acres with a pit floor at about elevation 5,480 feet. Quarrying could commence at any number of locations near the base of the ridge and advance toward higher elevations. An estimated 13.6 million tons of unprocessed stone is extractable from this deposit.

C. Overburden (note thickness/type)

Surface observations indicate that the proposed quarry pit area is covered with 0 to 3 feet of residual sandy gravel overburden. Actual thicknesses need to be confirmed with borings. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

D. Deposit Features

i. Rock Type/Description (use S&W rock descriptions)

The rock unit of interest in the study area is GRANITE, a plutonic igneous rock composed of quartz, orthoclase, plagioclase, magnetite, biotite, muscovite, and calcite. Plutonic refers to rocks that formed at considerable depths in the earth's crust from magma. Granite cools slowly and develops a coarse crystalline texture. Over time, this pluton was uplifted and exposed by erosion.

ii. Thickness/Depth (need minable thickness)

The maximum topography within the quarry pit area is about 170 feet based on a mine floor elevation of 5,480 feet.

iii. Rock Structure (block sizes/joint or fracture spacing)

a. Joints and Fractures

We noted three distinct joint sets in this outcrop. Average values for each joint set are presented in Table A.2-4.

TABLE A.2-4
JOINT MEASUREMENTS AT SAMPLED OUTCROP

Joint Set	Dip Angle° (degrees)	Dip Direction (azimuth)	Joint Spacing (feet)
J1	70	64	8 to 10
J2	19	278	5 to 6
J3	79	159	0.5 to 4

b. Estimated block size distribution

Block size distribution is presented in Table A.2-5. It reflects the joint spacing measured at various locations on the outcrop.

TABLE A.2-5
ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 6.0 ft	10
4.0 – 6.0 ft	50
2.0 – 4.0 ft	25
0.5 – 2.0 ft	15
< 0.5 ft	5

c. Deleterious Materials, including orientation and thickness (Note: Ash layers/faults/weather contacts, shear zones, fillings, scoriaceous zones, rubble zones, etc. This is internal waste that reduces deposit size.)

Based on observation of surface outcrops, about 25 percent of this stone could be highly weathered or altered at the ground surface and along joints, and therefore, be unsuitable for ballast material.

d. Rock Quality Designation (RQD)

RQD of the sampled outcrop is estimated at 70 to 85 percent. This reflects the vertical jointing and generally massive nature of the outcrop.

e. Samples for testing (200 pounds minimum; describe sample; taken)

On 30 October 2006, roughly 240 lbs of rock samples were collected at waypoint MT4007, at about 5,510 feet elevation. The samples filled six canvas bags.

f. Rock hammer test

The granite at the sample site fractures with 5 to 10 blows from a standard geologic rock hammer, indicating medium-high strength.

g. Schmidt hammer tests

Nine Schmidt-hammer field tests were performed at the sample collection site. Test results are presented in Table A.2-6. The rocks tested were generally fresh; slight weathering on some test surfaces did not seem to affect the results. During all tests, the instrument was oriented perpendicular to the rock surface.

TABLE A.2-6
NORTH CLAYTON SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/ Dip Direction
1	58	59/002
2	52	90/176
3	52	19/098
4	51	68/200
5	61	60/229
6	59	69/229
7	58	80/159
8	49	80/168
9	48	70/170

iv. Groundwater — Is there evidence groundwater is near surface? Want to avoid groundwater in pit as this causes permitting problem.

We saw no evidence of groundwater in the study area. We do not anticipate groundwater inflow into the quarry pit during quarry operations. Seasonal surface water inflow should be minimal.

The closest observed water source is at Alkali, located about 3.4 miles northeast of the study area. At the time of our visit, a privately owned hot spring there was producing 10 to 20 gallons per minute (gpm) of non-potable water. Wells may need to be drilled at, or water transported to, the site.

E. Future Explorations

Core drilling is recommended to recover subsurface samples and to characterize the quality of the granite within the proposed quarry pit. At least eight borings are recommended during the preliminary phase of exploration.

a. Drill rig access

The existing jeep trails are adequate for 4WD drill rig access during dry weather or road conditions.

b. Type of rig

The steep slopes in the quarry pit area will require track-mounted rock coring rigs for access and pioneer roads prepared by dozers in some places.

c. Approximate depths and total footage of borings

We propose a final quarry floor elevation of 5,480. Each boring should bottom 20 feet below this elevation, or at 5,460 feet. These depths vary from 45 feet on the western edge of the quarry to 170 feet at the highest point on the ridge. The total estimate of required coring is about 800 feet. If these cores reveal unexpected subsurface conditions (such as variable rock types or rock quality issues), additional coring may be needed to evaluate the quarry pit area.

d. Geophysics alignments

Surface geophysics may be performed if any irregularities or inconsistencies are noted in the preliminary borings.

3. ENVIRONMENTAL FEATURES

A. Vegetation (what type/how much/where)

Vegetation consists mainly of sage, desert grasses, and sparsely scattered Joshua trees, with about 10 to 15 percent ground cover.

B. Visibility (would quarry be visible from road?)

The plant site, siding, and spoil stockpile areas would be visible from Silver Peak Road—a well-traveled road between Silver Peak and Goldfield—located 1 mile northwest of the study area. The quarry pit would be visible from Montezuma Well Road, a well-maintained but infrequently traveled road, located 1 mile southwest of the study area.

4. OTHER FEATURES

A. Power (is power nearby or need on-site generation)

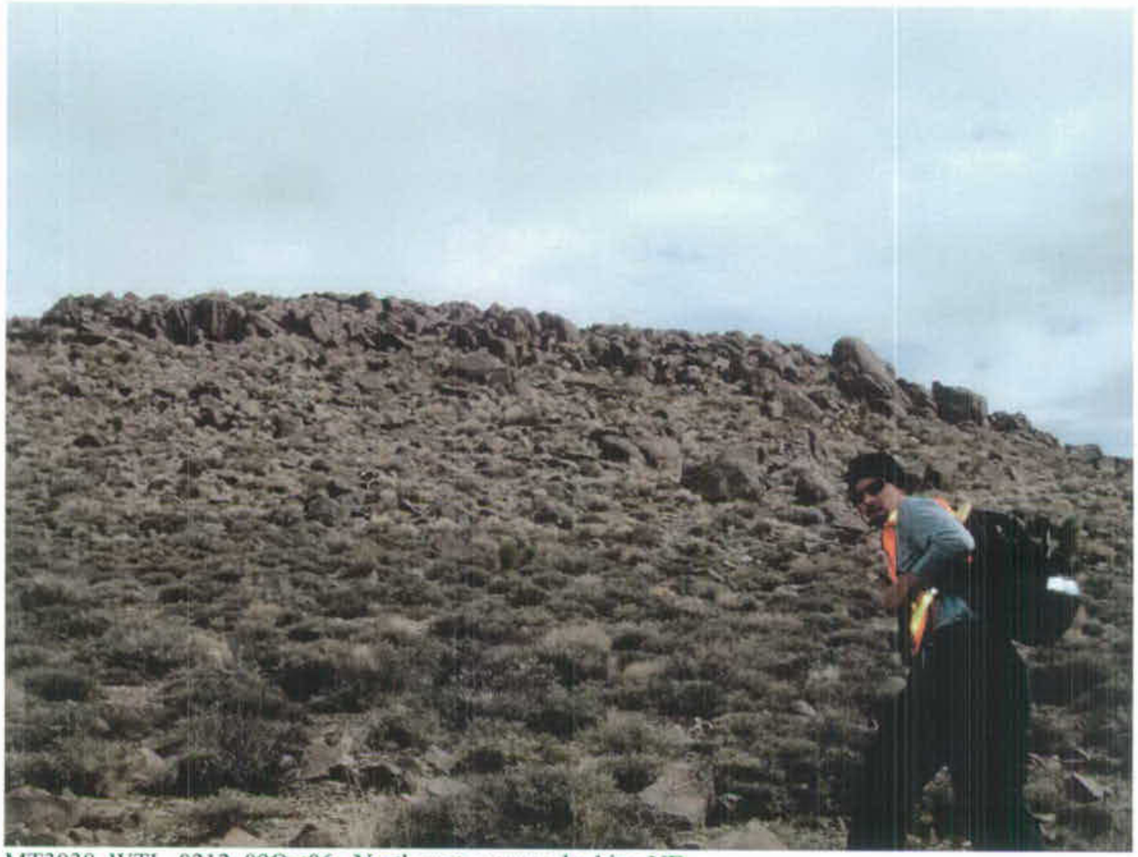
An existing power line runs through the southeastern quadrant of the study area. This power line is approximately 1 mile east of the plant site and is shown in Figure A.2-1.

B. Water (groundwater studies by others)

No data available on groundwater studies.

5. NORTH CLAYTON PHOTOS

MT4007_BKR_0164_28Oct06, MT4007_BKR_0165_28Oct06 and MT4007_BKR_0166_28Oct06: Panoramic view of sampled outcrop, looking W.



MT3038_WTL_0212_09Oct06: Northwest outcrop, looking NE.

MT3038_WTL_0213_09Oct06: Closeup of blocks of remnant granite from outcrop.

MT3038_WTL_0214_09Oct06: Looking N at both hills of pluton.

QUARRY FIELD EVALUATION CHECKLIST

Quarry Designation: GABBS RANGE
Field Team: Keith Rauch, Elizabeth Karcheski
October 31, 2006

1. SITE FEATURES (show on map to the extent possible)

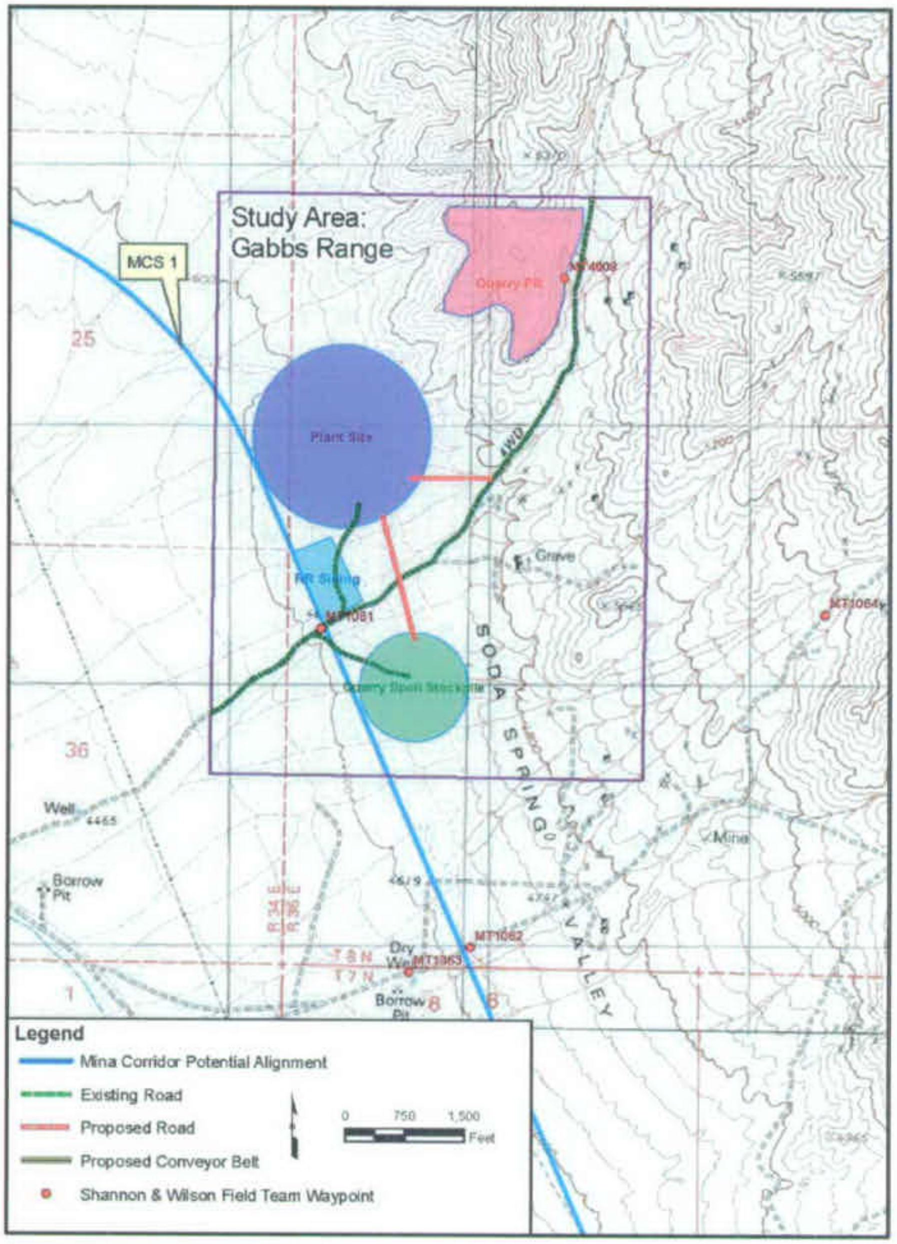


Figure A.3-1. Gabbs Range Ballast Quarry Conceptual Layout

A. Topography

The Gabbs Range study area is situated on the west slope of the Gabbs Valley Range, adjacent to Soda Spring Valley. Slopes across the study area range from moderate to steep (averaging about 40 percent), varying greatly due to multiple hills and ridges. The topography is much more gentle on the alluvial fans to the southwest of the study area in Soda Spring Valley.

B. Surface Water (near stream/river?), what flow?, intermittent)

Dry washes cross the alluvial fan in the south half of the study area. They may carry significant water flows during major rain events.

C. Existing Access roads (where are they? can they be improved? show on maps)

Access to the study area is by way of existing jeep trails that originate at highway US 95 near Luning, Nevada (N38.50598°, W118.17954°). To reach the proposed quarry site, proceed northeast on 1st Street for 0.33 mile to intersection; turn east on jeep trail and proceed 1.75 miles to intersection; turn northeast and proceed 2.2 miles to MT4008 (N38.52612°, W118.12209°). The quarry site is to the west of and adjacent to this trail. The average slope on these trails is about 2 percent with a maximum slope of 11 percent.

The existing 5 miles of jeep trails (Figure A.3-1) are adequate for exploration drill rigs during dry weather but will need improvement to serve as access roads to an active quarry site. Existing roads can be used for access to the proposed quarry facilities, but new roads could be easily established for more efficient transportation routes on the alluvial fan.

D. Room for Plant/Office Facilities (need 80 acres of flat land)

There is adequate acreage available for a 93-acre plant site on the alluvial fan southwest of the proposed quarry (Figure A.3-1). The surface slopes downward to the west and toward the alignment at a 6 percent average grade. The alluvial sandy gravel and gravelly sand can be removed by conventional methods for excavations and for structural fill. This soil can be used to improve the local jeep trails. It may also be suitable for railroad subballast material. Some preliminary site characteristics are listed in Table A.3-1.

TABLE A.3-1
GABBS RANGE PLANT SITE CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,675
Average slope (percent)	6
Maximum slope (percent)	10

E. Room for Railroad Siding (where would siding be for loading ballast cars?)

There is adequate room for a 12-acre siding facility adjacent to the proposed alignment at N38.51535°, W118.13247° (Figure A.3-1). The proposed siding site lies topographically above and slopes downward toward the rail alignment. Therefore, sandy gravel and gravelly sand alluvium must be excavated to level the site. This soil can be used to improve the local jeep trails. It may also be suitable for railroad subballast material. Some preliminary site characteristics are listed in Table A.3-2.

TABLE A.3-2
GABBS RANGE RAILROAD SIDING PRELIMINARY CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,650
Average slope (percent)	7
Maximum slope (percent)	10

F. Room for Spoil Stockpile (need ~flat to ~gently sloping topo)

Figure A.3-1 shows the proposed 34-acre waste stockpile site. It lies about 0.6 mile south of the proposed plant site. No earthwork is required to prepare the site. Existing roads will need improvement to support heavy construction equipment. Site characteristics are presented in Table A.3-3.

TABLE A.3-3
GABBS RANGE QUARRY SPOIL STOCKPILE CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,718
Average slope (percent)	7
Maximum slope (percent)	10

G. Access Roads (to highway and railroad alignment)

All-weather access to the site will require construction of about 5 miles of improvements to existing jeep trails and about 0.5 mile of new road. Some preliminary road construction estimates are listed in Table A.3-4.

TABLE A.3-4
GABBS RANGE PRELIMINARY ROAD CONSTRUCTION ESTIMATES

From	To	Improved (mi)	New (mi)	Avg. percent Slope	Max percent Slope
US 95	Turn 1	0.34	0	2	7
Turn 1	Turn 2	1.75	0	0	3
Turn 2	M1 Align	1.06	0	3	8
M1 Align	MT4008	1.14	0	6	11
M1 Align	Spoil Pile	0.48	0	5	10
M1 Align	Plant	0.28	0	3	5
Quarry Turnoff	Plant	0	0.20	4	6
Plant	Spoil Pile	0	0.31	0	2
TOTAL		5.04	0.51		

i. Topographic conditions for new roads

The 3.4-mile jeep trail between US 95 and the quarry is easily negotiable by 4WD vehicles during dry periods, but will require improvements to provide all-weather access. Minor fill with culverts may be required in a few locations, but no road cuts or major fills are anticipated. New roads for efficient interior transportation can be easily established on the alluvial fan.

The 0.76-mile section between the plant site and the spoil stockpile will be used primarily by loaded dump trucks and heavy construction equipment. It will need to be built to support this traffic under all weather conditions. The gentle to moderate slopes on this proposed route will require no significant earthwork during construction.

ii. Cut slopes (soil/rock)

Existing topographic conditions and anticipated traffic patterns lead us to expect that no significant soil or rock cuts will be required during road construction at this site. See discussion in the previous section.

2. DEPOSIT FEATURES

A. Location (shown on 1:24,000 scale topo to the extent possible; record T, R, Sec)

The 915-acre study area (Figure A.3-1) is located in the SW/4 sec 30, T 8 N, R 35 E (Mineral County, Nevada, Mt. Diablo Meridian).

B. Tonnage (provided in this deposit [W x L x H])

Outcrops in the study area indicate that the proposed quarry pit will support a multiple-bench operation covering about 52 acres with a pit floor at about elevation 5,000 feet. Assuming this pit floor elevation, the minable thickness ranges from 20 to 180 feet and averages about 77 feet. An estimated 14.3 million tons of unprocessed stone is extractable from this deposit.

C. Overburden (note thickness/type)

Surface observations indicate that the proposed quarry pit area is covered with 0 to 5 feet of sandy gravel and gravelly sand overburden. Actual thicknesses need to be confirmed with borings. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

D. Deposit Features

i. Rock Type/Description (use S&W rock descriptions)

The rock unit of interest in the study area is GRANITE, a high-silica plutonic igneous rock composed of quartz , and orthoclase and plagioclase feldspars. Plutonic refers to rocks that formed at considerable depths in the earth's crust from magma. Granite cools slowly and develops a coarse crystalline texture. Over time, this pluton was uplifted and/or exposed by erosion.

ii. Thickness/Depth (need minable thickness)

Based on the assumed pit floor elevation, the maximum thickness of granite within the quarry pit area is about 180 feet.

iii. Rock Structure (block sizes/joint or fracture spacing)

a. Joints and Fractures

We noted three distinct joint sets in this outcrop. Average values for each joint set are presented in Table A.3-5.

TABLE A.3-5
JOINT MEASUREMENTSE AT SAMPLED OUTCROP

Joint Set	Dip Angle° (degrees)	Dip Direction (azimuth)	Joint Spacing (feet) From	Joint Spacing (feet) To
J1	50	282	1	1
J2	58	26	0.5	3
J3	75	310	1	2

b. Estimated block size distribution

Block size distribution is presented in Table A.3-6.

TABLE A.3-6
ESTIMATED BLOCK SIZE DISTRIBUTION

Block Size	Percent Distribution
> 1.0 ft	20
0.5 to 1.0 ft	50
< 0.5 ft	30

c. Deleterious Materials, including orientation and thickness (Note: Ash layers/faults/weather contacts, shear zones, fillings, scoriaceous zones, rubble zones, etc. This is internal waste that reduces deposit size.)

Based on observation of surface outcrops, about 15 percent of the excavated stone could be highly weathered or altered and therefore unsuitable for ballast material.

d. Rock Quality Designation (RQD)

An RQD estimate of the sampled outcrop is 50 to 70 percent. This too, reflects the closely spaced jointing of the outcrop.

e. Samples for testing (200 pounds minimum; describe sample; taken)

On 31 October 2006, roughly 260 lbs of rock samples were collected at waypoint MT4008, at about elevation 5,000 feet. The samples filled six canvas bags.

f. Rock hammer test

The granite rock we sampled typically fractures with 15 to 20 blows from a standard geologic rock hammer, indicating high strength.

g. Schmidt hammer tests

Ten Schmidt-hammer field tests were performed at the sample collection site. Test results are presented in Table A.3-7. The rocks tested were generally fresh; slight weathering on some test surfaces did not seem to affect the results. During all tests, the instrument was oriented perpendicular to the rock surface.

TABLE A.3-7
GABBS RANGE SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/ Dip Direction
1	68	50/280
2	40	50/280
3	40	60/071
4	59	58/026
5	70	75/310
6	63	80/103
7	48	64/310
8	58	73/105
9	57	44/352
10	60	46/237

iv. Groundwater — Is there evidence groundwater is near surface? Want to avoid groundwater in pit as this causes permitting problem.

No wells or springs were observed within the production area. A well casing was observed approximately 1.8 miles to the southwest along the access road. A dry well is shown in the U.S. Geological Survey (USGS) topographic map about one mile southeast of the proposed railroad siding.

We saw no evidence of groundwater in the study area. We do not anticipate any groundwater inflow into the quarry pit during quarry operations. Seasonal surface water inflow should be minimal.

The nearest observed water source is at Luning, located about 2.5 miles southwest of the study area. Wells may need to be drilled at, or water transported to, the site.

E. Future Explorations

Core drilling is recommended to recover subsurface samples and to characterize the quality of the granite within the proposed quarry pit.

a. Drill rig access

The existing jeep trails are adequate for drill rig access during dry weather. Bulldozers may also be required to aid in sloping the hillside or breaking trail for the drill rig to ascend the hillsides.

b. Type of rig

The steep slopes in the quarry pit area will require track-mounted coring rigs for access.

c. Locations and depths of borings

At least ten borings are recommended for a preliminary subsurface explorations program. We propose a final average quarry floor elevation of 5,000 feet. Each boring should bottom 20 feet below this elevation, or 4,980 feet. These depths range from 60 feet at the south end of the quarry to 220 feet. The estimate of total required coring is 1,200 feet. If these cores reveal unexpected subsurface conditions (such as variable rock types or rock quality issues), additional coring may be needed to evaluate the quarry pit area.

d. Geophysics alignments

Due to good outcrop exposures and drill access, no surface geophysics are anticipated.

3. ENVIRONMENTAL FEATURES

A. Vegetation (what type/how much/where)

Vegetation consists mainly of sage, desert grasses, and sparsely scattered Joshua trees, with about 10 to 15 percent ground cover.

B. Visibility (would quarry be visible from road?)

The entire plant site, including the quarry, would be visible from the village of Luning on highway US 95, located about 2.5 miles southwest of the study area.

4. OTHER FEATURES

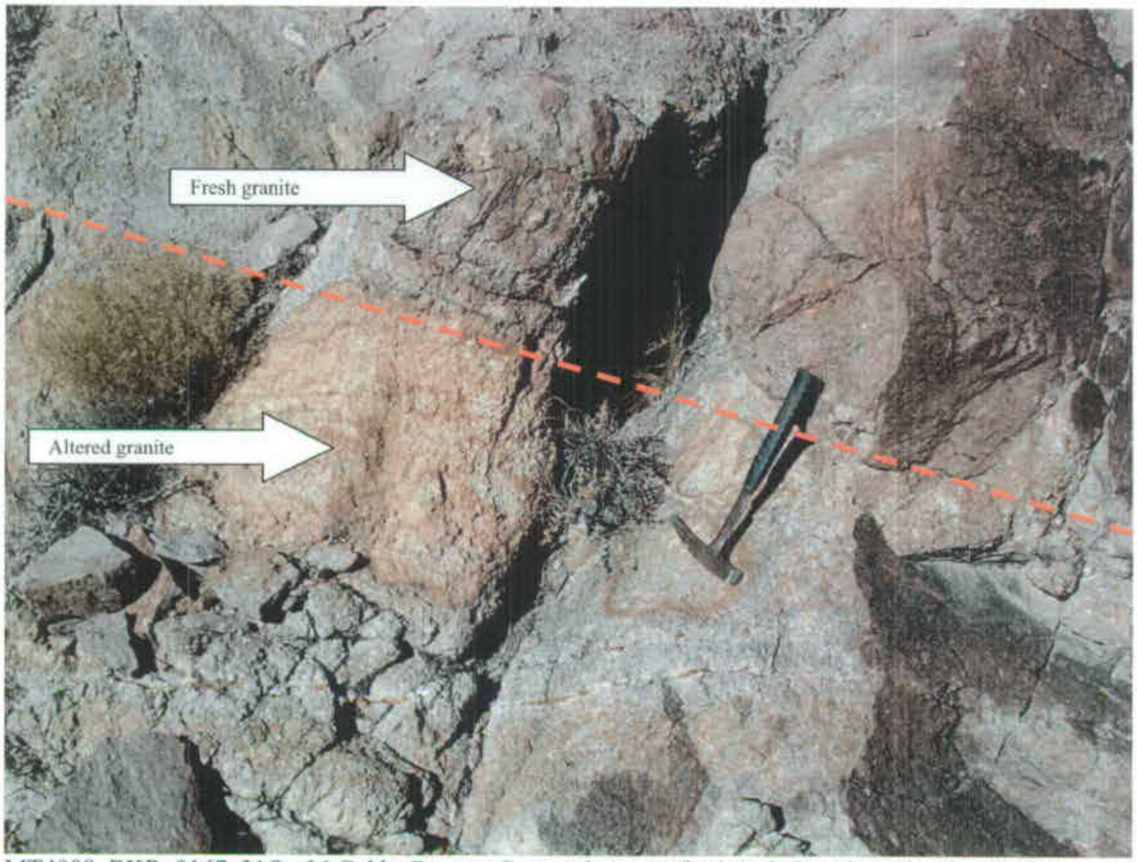
A. Power (is power nearby or need on-site generation)

A northwest-trending power line lies near the southwest corner of the study area. This power line is approximately 0.7 mile west of the plant site and is shown in Figure A.3-1.

B. Water (groundwater studies by others)

No data are available on groundwater studies.

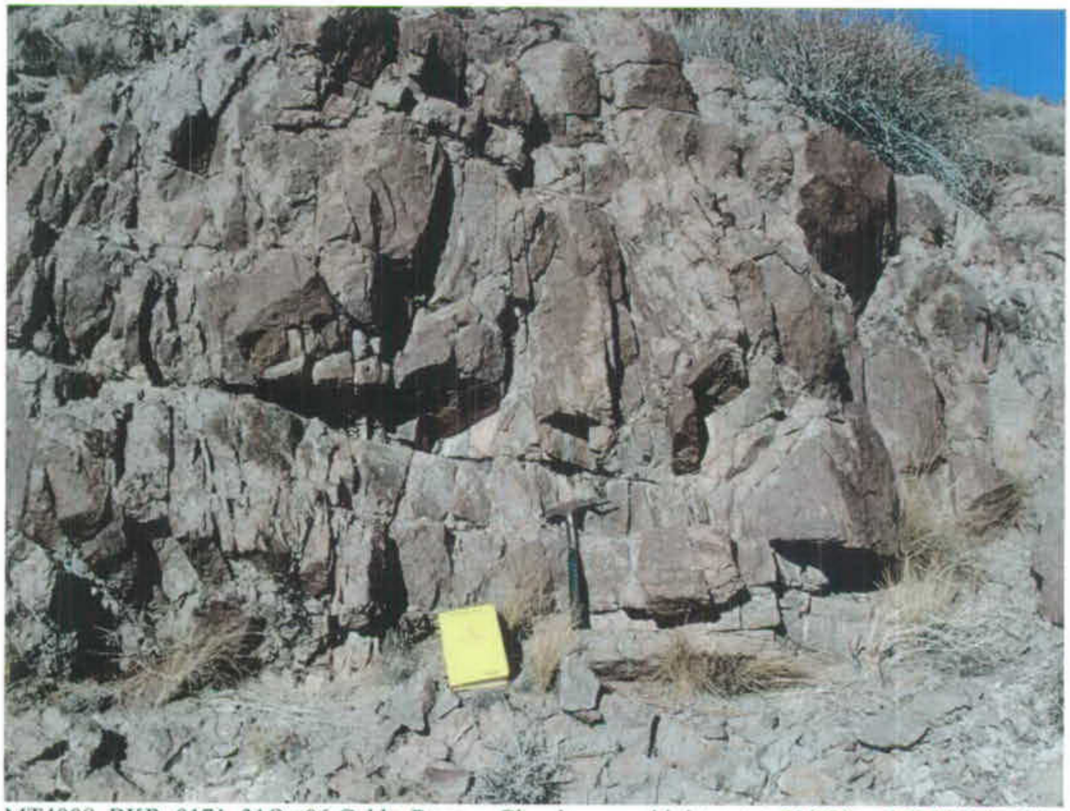
5. GABBS RANGE PHOTOS



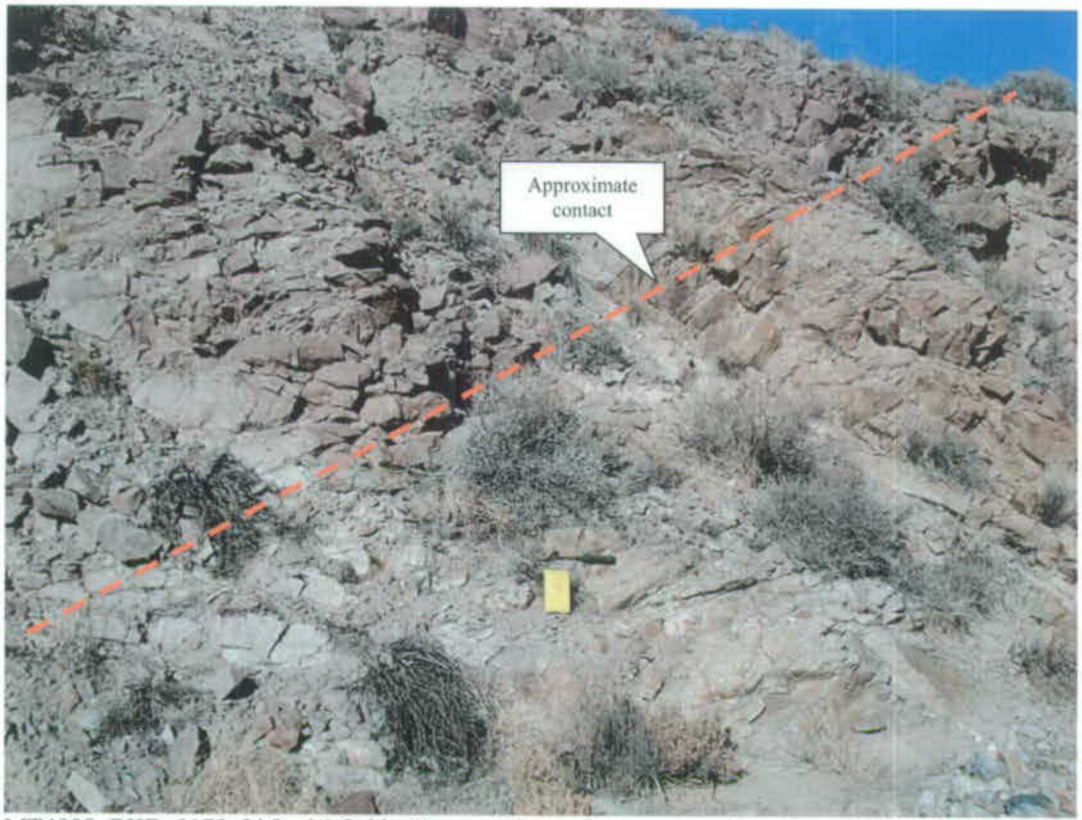
MT4008_BKR_0167_31Oct06 Gabbs Range: Contact between fresh and altered granite, S end of outcrop; looking W.

MT4008_BKR_0168_31Oct06 and MT4008_BKR_0169_31Oct06 Gabbs Range: View of outcrop along wash; looking NW.

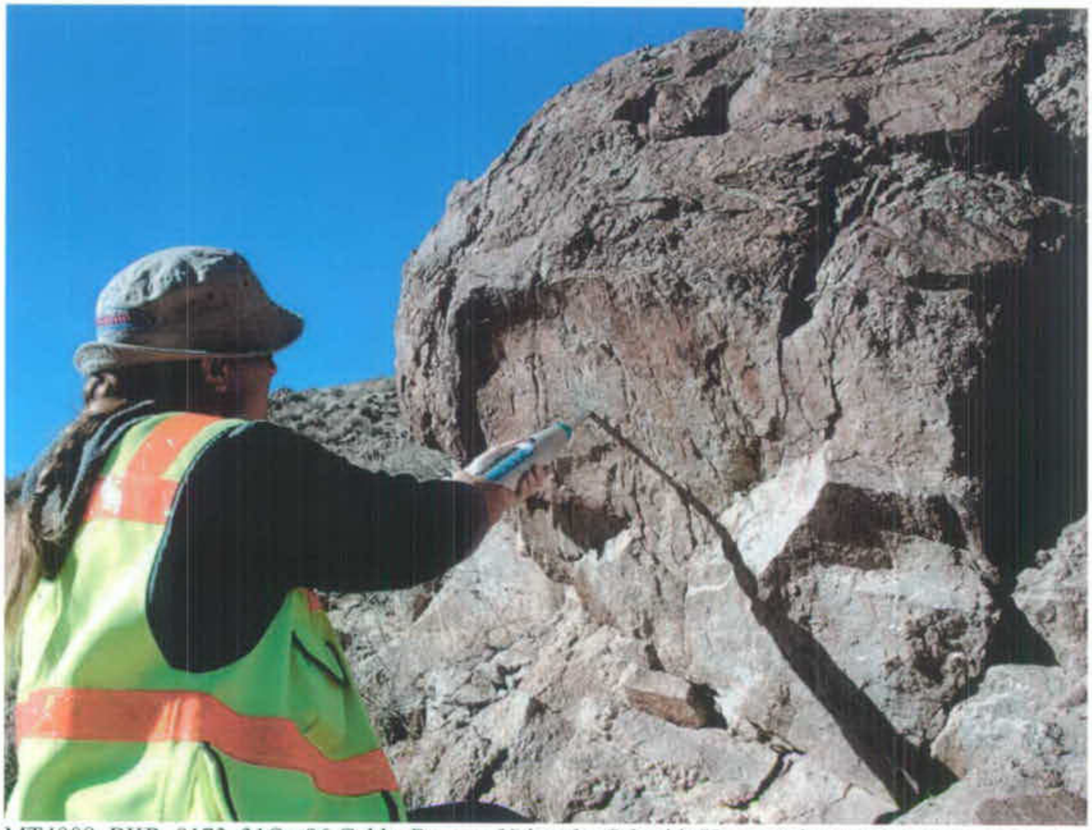
MT4008_BKR_0170_31Oct06 Gabbs Range: Closely-spaced jointing, 50/282 and 75/310; looking W.



MT4008_BKR_0171_31Oct06 Gabbs Range: Closely-spaced joint set at 50/282 and 75/310; looking W.



MT4008_BKR_0172_31Oct06 Gabbs Range: Contact between two intrusive units, N end of outcrop; looking NW.



MT4008_BKR_0173_31Oct06 Gabbs Range: Using the Schmidt-Hammer instrument on an outcrop.

MT4008_BKR_0174_31Oct06 Gabbs Range: Panorama of sampled outcrop; looking SW to NW.

QUARRY FIELD EVALUATION CHECKLIST

Quarry Designation: GARFIELD HILLS
Field Team: Keith Rauch, Elizabeth Karcheski
November 2, 2006

1. SITE FEATURES (show on map to the extent possible)

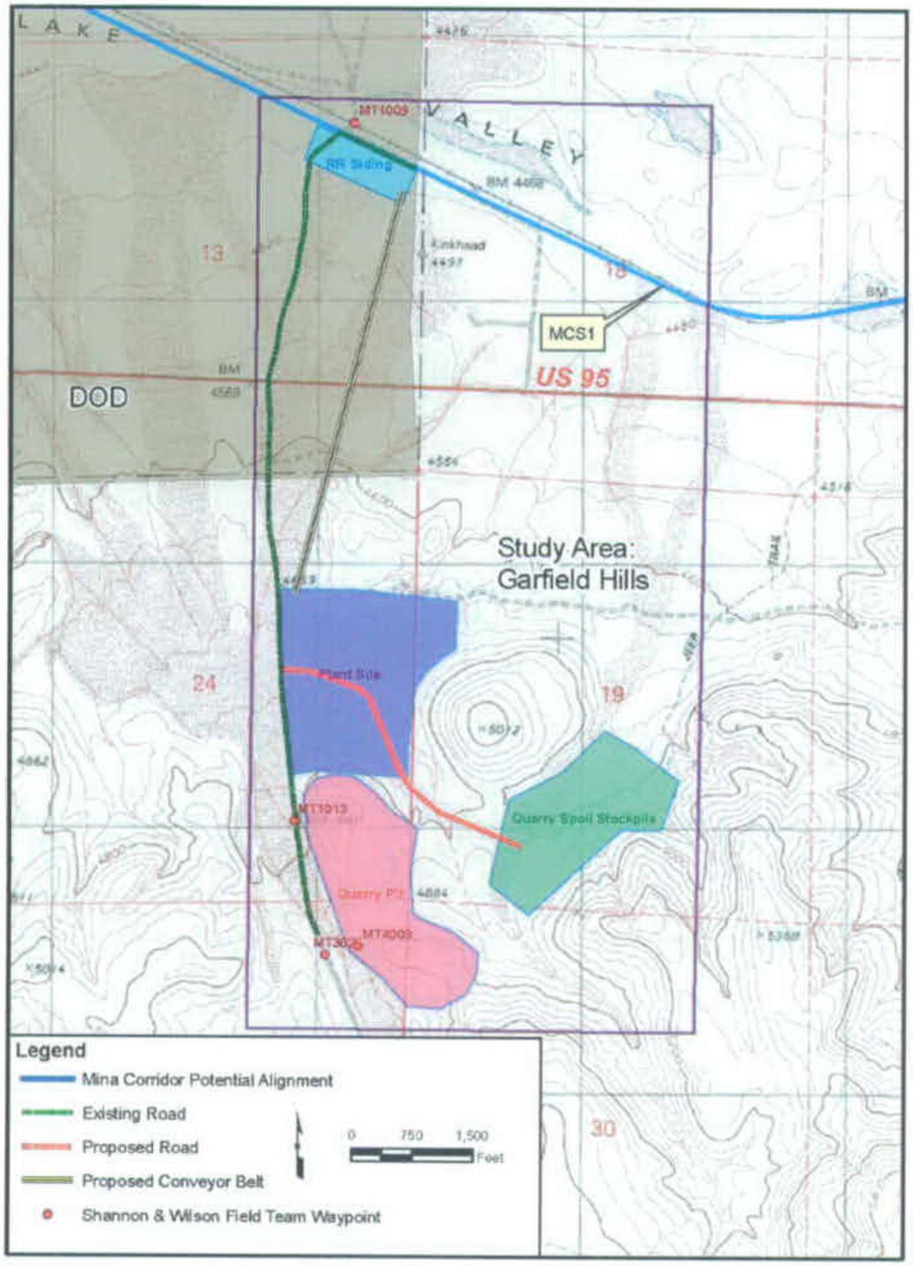


Figure A.4-1. Garfield Hills Ballast Quarry Conceptual Layout

A. Topography

The Garfield Hills study area is located about 8.8 miles east of Hawthorne, Nevada, on highway US 95. It is situated on the north slope of the Garfield Hills and in the adjacent Walker Lake Valley. Slopes across the study area range from flat to precipitous, varying greatly due to multiple hills and ridges. The topography is more moderate on the alluvial fans in the Walker Lake Valley.

B. Surface Water (near stream/river?), what flow?, intermittent)

No flowing streams were observed in the study area. Occasional dry washes cross the alluvial fan within the study area. They may carry significant water flows during major rains.

A dry wash borders the western edge of the quarry site. Scattered boulders were observed in the dry wash, and may have been deposited during times of substantial flow. Flooding potential would have to be mitigated for a quarry operation at Garfield Hills.

C. Existing Access roads (where are they?, can they be improved? show on maps)

Access to the study area is by way of Garfield Flats Road (Figure A.4-1), a gravel road that originates at highway US 95 (N38.55024°, W118.47216°) and runs along the west boundary of the study area to the quarry sample site (MT4009 at N38.53556°, W118.46973°). This road will allow good access for exploration drill rigs. It is about 40 feet wide and is graded regularly. Additional rock surfacing may have to be added for all-weather use by heavy construction equipment. About 1 mile of new roads will need to be built to provide access to the plant site, railroad siding, and spoil stockpile.

D. Room for Plant/Office Facilities (need 80 acres of flat land)

Minimizing the visual impact of this operation limits the options for locating the plant site. Adequate space is available for a 94-acre plant site on the alluvial fan along Garfield Flats Road and north of the proposed quarry (N38.54057°, W118.46851°), as shown in Figure A.4-1. The surface slopes downward to the north at moderate grades (range 1-9 percent, average 4 percent). The alluvial sandy gravel and gravelly sand can be removed by conventional methods and can be used to fill and level the site. Some preliminary site characteristics are listed in Table A.4-1.

TABLE A.4-1
GARFIELD HILLS PLANT SITE PRELIMINARY CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,700
Average slope (percent)	4
Maximum slope (percent)	9

E. Room for Railroad Siding (where would siding be for loading ballast cars?)

There is adequate room for a 14-acre siding facility adjacent to the existing railroad alignment, as shown in Figure A.4-1. The proposed MCS 1 alignment lies within 1,000 feet of the highway at its closest point, so it will be visible from US 95. It will be necessary for trucks carrying ballast to cross US 95. If a conveyor is used to transport the rock to the siding, it could be routed over or under US 95. The proposed siding site is practically flat and will require little earthwork. Some preliminary characteristics are listed in Table A.4-2.

TABLE A.4-2
GARFIELD HILLS RAILROAD SIDING PRELIMINARY CHARACTERISTICS

Item	Value
Average site elevation (feet)	4,485
Average slope (percent)	1
Maximum slope (percent)	4

F. Room for Spoil Stockpile (need ~flat to ~gently sloping topo)

Figure A.4-1 shows a proposed 61-acre spoil stockpile site (N38.53559°, W118.45831°). It lies about 0.6 mile southeast of the proposed plant site. Minimizing the visual impact of this operation limits the options for its location. The surface slopes downward to the north at relative steep grades (range 1 to 40 percent, average 12 percent). Despite the steep side slopes, no earthwork should be required to prepare the site. About 0.8 mile of new road construction will be needed to access the site from the plant. Some characteristics of the site are presented in Table A.4-3.

TABLE A.4-3
GARFIELD HILLS QUARRY SPOIL STOCKPILE PRELIMINARY CHARACTERISTICS

Item	Value
Average site elevation (feet)	4,820
Average slope (percent)	12
Maximum slope (percent)	40
New road construction (mi)	0.8

G. Access Roads (to highway and RR alignment)

All-weather access to the site would require construction of roughly 1 mile of new and 2.4 miles of improved roadways. Some preliminary road construction estimates are listed in Table A.4-4.

TABLE A.4-4
GARFIELD HILLS PRELIMINARY ROAD CONSTRUCTION ESTIMATES

From	To	Improved (mi)	New (mi)	Avg. Percent Slope	Max. Percent Slope
US 95	Quarry	1.20	0.00	3	6
US 95	Siding	1.20	0.20	2	4
Plant	Spoil Pile	0.00	0.75	3	9
TOTALS		**2.40**	**0.95**		

i. Topographic conditions for new roads

The 1.2-mile section of Garfield Flats Road between US 95 and the proposed quarry is easily negotiable by 4WD vehicles during dry periods, but may require improvements to provide all-weather access. Minor fill with culverts may be required in a few locations. No road cuts or major fills are needed.

The 1.2-mile section of unimproved local road between US 95 and the siding will require improvements to provide all-weather access to trucks. It should be noted that this proposed route crosses the Hawthorne Ammunition Depot.

Trucks hauling waste rock and heavy construction equipment will use the 0.8-mile section of new road between the plant site and the spoil stockpile. It should be built to support this traffic under all weather conditions. The moderate slopes on this proposed route will require no significant earthwork for heavy-haul trucks during construction.

ii. Cut slopes (soil/rock)

Existing topographic conditions and anticipated traffic patterns lead us to expect that no significant soil or rock cuts will be required during road construction at this site. See discussion in the previous section.

2. DEPOSIT FEATURES

A. Location (shown on 1:24,000 scale topo to the extent possible; record T, R, Sec)

The center of the 1,274-acre Study Area (Figure A.4-1) is located in the NW/4 sec 19, T 8 N, R 32 E (Mineral County, Nevada, Mt. Diablo Meridian).

B. Tonnage (provided in this deposit [W x L x H])

Outcrops in the study area indicate that the proposed quarry pit will support a multiple-bench operation covering 74 acres with a pit floor at about elevation 4,810 feet. Based on this pit floor level, the deposit thickness ranges from about 20 to 160 feet and averages about 76 feet. An estimated 42 million tons of unprocessed stone is extractable from this deposit.

C. Overburden (note thickness/type)

Surface observations indicate that the proposed quarry pit area is covered with 0 to 5 feet of sandy gravel overburden. Actual thicknesses need to be confirmed with borings. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

D. Deposit Features

i. Rock Type/Description (use S&W rock descriptions)

The rock unit of interest in the proposed quarry pit is BASALT, a dark, fine-grained extrusive igneous rock that forms at, or near, the surface as volcanic lava flows and shallow intrusions. It is a low-silica rock that is rich in MgO and CaO, consisting mostly of calcic plagioclase feldspar and olivine, with augite, magnetite, iddingsite, and calcite. Basalt generally cools quickly and has a glassy to very fine-grained crystalline texture. It often contains small spherical voids (vesicles) formed by the expansion of gas or steam during cooling. The vesicles in this outcrop are most often filled with zeolite crystals and are more numerous near the top of each flow.

The outcrop in the quarry area consists of multiple basalt flows with altered scoriaceous and rubble zones between flows. Occasionally, the scoria extends vertically through the basalt flows. These scoriaceous and rubble zones are considered unsuitable for ballast material.

ii. Thickness/Depth (need minable thickness)

The maximum thickness of basalt within the quarry pit area is about 160 feet, based on quarrying to an elevation level with adjacent natural grades.

iii. Rock Structure (block sizes/joint or fracture spacing)

a. Joints and Fractures

The outcrop is moderately jointed and fractured. We noted three distinct joint sets in this outcrop. Average values for each joint set are presented in Table A.4-5.

TABLE A.4-5
JOINT MEASUREMENTS AT SAMPLED OUTCROP

Joint Set	Dip Angle (degrees)	Dip Direction (azimuth)	Joint Spacing (ft)	
			From	To
J1	75	118	0.1	0.5
J2	74	166	0.1	0.5
J3	75	244	0.5	2.0

b. Estimated block size distribution

Block size distribution is presented in Table A.4-6.

**TABLE A.4-6
ESTIMATED BLOCK SIZE DISTRIBUTION**

Block Size	Percent Distribution
>6.0 ft	5
4.0 to 6.0 ft	10
2.0 to 4.0 ft	15
0.5 to 2.0 ft	50
<0.5 ft	20

c. Deleterious Materials, including orientation and thickness (Note: Ash layers/faults/weather contacts, shear zones, fillings, scoriaceous zones, rubble zones, etc. This is internal waste that reduces deposit size.)

Based on observation of surface outcrops, about 20 percent of this stone could be weak scoria and therefore unsuitable for ballast material (internal waste).

d. Rock Quality Designation (RQD)

Our RQD estimate of the sampled outcrop is 40 to 60 percent. This reflects the closely spaced jointing of the outcrop.

e. Samples for testing (200 pounds minimum; describe sample; taken)

On 02 November 2006, roughly 260 lbs of rock samples were collected at waypoint MT4009, at various locations between 4,830 and 4,870 feet elevation. The samples filled six canvas bags.

f. Rock hammer test

The basalt rock we sampled typically fractures with 15 to 20 blows from a standard geologic rock hammer, indicating high strength.

g. Schmidt hammer tests

Ten Schmidt-hammer field tests were performed at the sample collection site. Test results are presented in Table A.4-7. The rocks tested were generally fresh; slight weathering on some test surfaces did not seem to affect the results. During all tests, the instrument was oriented perpendicular to the rock surface.

TABLE A.4-7
GARFIELD HILLS SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface Dip/Dip Direction
1	52	90/215
2	53	71/246
3	58	63/168
4	52	88/174
5	38	81/121
6	47	30/135
7	57	63/270
8	60	71/156
9	54	80/074
10	50	68/114

iv. Groundwater — Is there evidence groundwater is near surface? Want to avoid groundwater in pit as this causes permitting problem.

No visible wells or springs were observed within the production area. We saw no evidence of groundwater in the study area. We do not anticipate any groundwater inflow into the quarry pit during quarry operations. Seasonal surface water inflow should be minimal.

E. Future Explorations

Core drilling is recommended to recover subsurface samples and to characterize the quality of the basalt within the proposed quarry pit.

a. Drill rig access

The existing jeep trails are adequate for drill rig access during dry weather.

b. Type of rig

The steep slopes in the quarry pit area will require track-mounted coring rigs for access, with dozer preparation and assistance being necessary in some cases.

c. Locations and depths of borings

At least 14 proposed coring locations are recommended for a preliminary subsurface exploration program. We propose a final quarry floor elevation of 4,810 feet. Each boring should bottom 20 feet below this elevation, or 4,790 feet. These depths range from 50 feet at the north end of the quarry to about 180 feet at the highest point on the southern ridge. The estimate of total required coring is about 1,400 feet. If these cores reveal unexpected subsurface conditions (such as variable rock types or rock quality issues), additional coring may be needed to evaluate the quarry pit area.

d. Geophysics alignments

The Garfield Hills site has good outcrop exposures; however, the variable nature of basalt flows in this region may be reason to perform a few to several geophysical lines between borings after rock coring.

3. ENVIRONMENTAL FEATURES

A. Vegetation (what type/how much/where)

Vegetation consists mainly of sage, desert grasses, and sparsely scattered Joshua trees, with about 10 to 15 percent ground cover.

B. Visibility (would quarry be visible from road?)

The quarry, plant, and siding would be visible from highway US 95, which runs through the north half of the study area.

4. OTHER FEATURES

A. Power (is power nearby or need on-site generation)

An east-trending power line lies near the center of the study area (Figure A.4-1). This power line is adjacent to the north side of the plant site.

B. Water (groundwater studies by others)

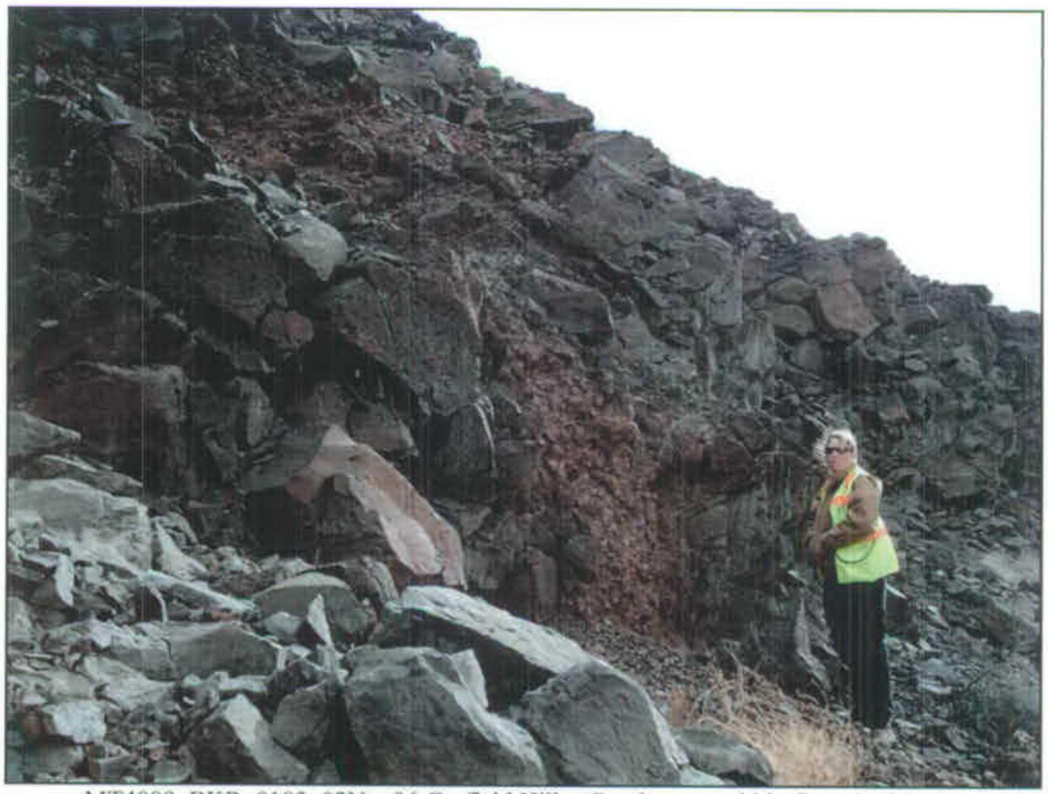
No data available on groundwater studies.

5. GARFIELD HILLS PHOTOS

MT4009_BKR_0177_02Nov06, MT4009_BKR_0178_02Nov06 and MT4009_BKR_0179_02Nov06
Garfield Hills: Panorama of sampled outcrop; looking N to E.

MT4009_BKR_0180_02Nov06 and MT4009_BKR_0181_02Nov06 Garfield Hills: Panorama of sampled outcrop; looking SE.

MT4009_BKR_0182_02Nov06 Garfield Hills: Scoria waste zone within flow; looking SE.



MT4009_BKR_0183_02Nov06 Garfield Hills: Scoria zone within flow; looking S.

QUARRY FIELD EVALUATION CHECKLIST

Quarry Designation: WEBER DAM
Field Team: Keith Rauch, Elizabeth Karcheski
November 3, 2006

1. SITE FEATURES (show on map to the extent possible)

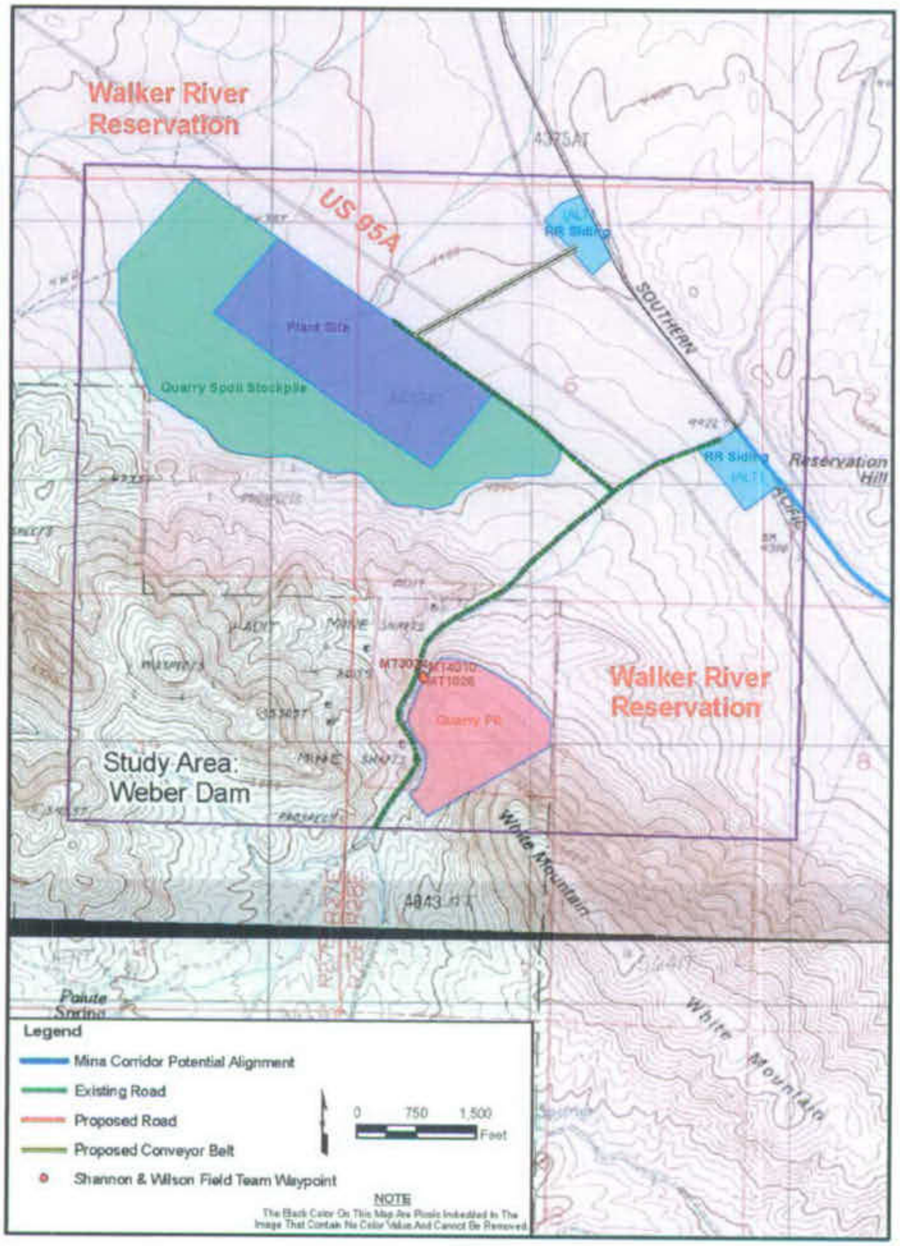


Figure A.5-1. Weber Dam Ballast Quarry Conceptual Layout

A. Topography

The Weber Dam quarry study area (Figure A.5-1) is located about 7 miles northwest of Schurz, and 15 miles east of Yerington, Nevada, on highway US 95A. It is situated on the north end of White Mountain and lies in the Walker River Indian Reservation. Slopes across the study area range from flat to precipitous and varying greatly due to multiple hills and ridges. The topography is more moderate on the alluvial fans in the Walker River valley.

B. Surface Water (near stream/river?), what flow?, intermittent)

No flowing streams were observed in the study area. The Walker River is about 1 mile east of the proposed railroad siding. It was flowing at about 90 cu ft/sec (40,380 gal/min) at the time of this study (Figure A.5-2).

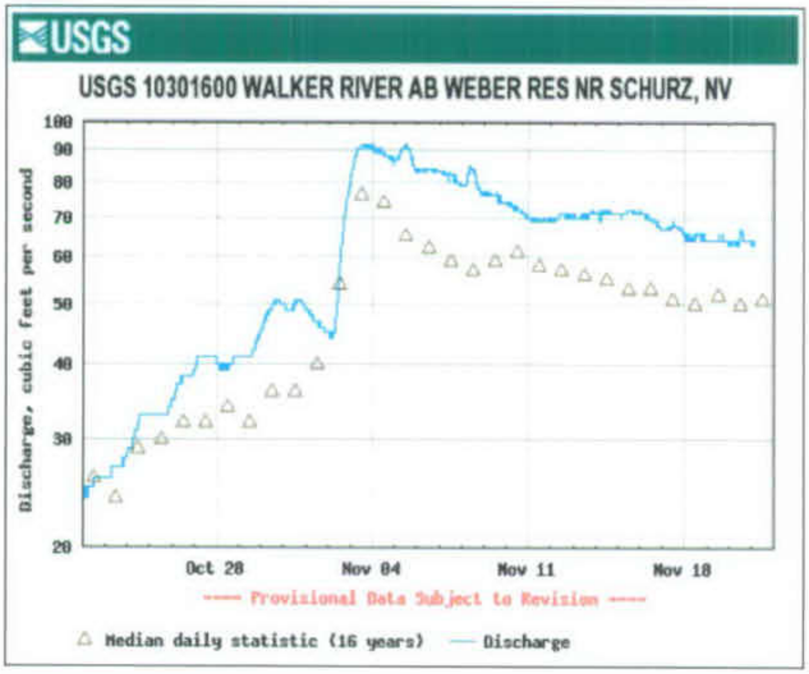


Figure A.5-2. Discharge, Cubic Feet per Second, Walker River Near Schurz, Nevada

C. Existing Access roads (where are they?, can they be improved? show on maps)

Access to the study area is by way of a local gravel road (Figure A.5-1) that intersects highway US 95A at N39.01608°, W118.89020° and runs southwesterly within the study area to the quarry sample site (MT4010 at N39.00860°, W118.89960°). This road will provide access for exploration drill rigs during dry weather, but may need improvement to permit all-weather access to an active quarry site. About 1.9 miles of improvements to existing roads will be needed to provide access to the plant site, railroad siding, and spoil stockpile.

D. Room for Plant/Office Facilities (need 80 acres of flat land)

There is adequate space for a plant site at N39.01958°, W118.90298° (approximately 96 acres, as shown in Figure A.5-1). This proposed site is adjacent to highway US 95A and about 0.9 mile northwest of the quarry site. The surface slopes down to the northeast at a lower gradient (range 0 to 5 percent, average 2 percent). It lies about 500 feet southwest of US 95A and is visible from the highway.

The alluvial sandy gravel and gravelly sand can be removed by conventional methods. Soil removed from the upper side of the site will be used to fill and level the lower side. Some preliminary characteristics are listed in Table A.5-1.

TABLE A.5-1
WEBER DAM QUARRY PLANT SITE CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,425
Average slope (percent)	2
Maximum slope (percent)	5

E. Room for Railroad Siding (where would siding be for loading ballast cars?)

There is adequate room for a 9-acre siding facility adjacent to the existing railroad alignment. There is no location in this vicinity that visually screens a siding site from US 95A, because the track lies within 0.2 mile of the highway at this point. It will be necessary for haul trucks carrying ballast to cross US 95A. Alternatively, a conveyor belt could be built to transport ballast to a siding. The proposed siding site slopes downward to the northeast.

If fill is needed for construction of this siding, it can probably be obtained from the plant site or from a local borrow pit. Characteristics of the site are presented in Table A.5-2.

TABLE A.5-2
WEBER DAM QUARRY RAILROAD SIDING CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,440 and 4,390
Average slope (percent)	1
Maximum slope (percent)	3

F. Room for Spoil Stockpile (need ~flat to ~gently sloping topo)

Figure A.5-1 shows the proposed 100-acre spoil stockpile site at N39.02027°, W118.90897°, adjacent to the proposed plant site. The surface slopes downward to the northeast at moderate grades (range 1 to 10 percent, average 3 percent). No earthwork should be required to prepare the site. About 0.7 mile of existing road improvements will be needed to access the site. It lies within 500 feet of US 95A and is visible from the highway. Some site characteristics are listed in Table A.5-3.

TABLE A.5-3
WEBER DAM QUARRY SPOIL STOCKPILE CHARACTERISTICS

Item	Value
Average site elevation (ft)	4,470
Average slope (percent)	3
Maximum slope (percent)	10
New road construction (miles)	0.7

G. Access Roads (to highway and RR alignment)

All-weather access to the site will require improvement of roughly 1.9 miles of existing roadways. Some preliminary road construction estimates are listed in Table A.5-4.

TABLE A.5-4
WEBER DAM QUARRY PRELIMINARY ROAD CONSTRUCTION ESTIMATES

From	To	Improved (mi)	New (mi)	Avg. Percent Slope	Max. Percent Slope
US 95A	Quarry	1.04	0.00	5	12
Frontage Road	Plant	0.67	0.00	2	4
US 95A	Siding	0.20	0.00	2	5
TOTALS		**1.90**	**0.00**		

i. Topographic conditions for new roads

The 1.04-mile section of the local road between US 95A and the quarry is easily negotiable by 4WD vehicles during dry periods, but may require improvements to provide all-weather access for trucks hauling ballast from the quarry. Minor fill with culverts may be required in a few locations. Due to the moderate slopes, no roadcuts or major fills are anticipated.

The 0.67-mile section of frontage road access to the plant site and spoil stockpile area will require improvements to provide all-weather access for trucks hauling ballast from the quarry. Due to the gentle slopes, no roadcuts or major fills are anticipated.

The 0.20-mile section of local road between US 95A and the siding will require improvements to provide all-weather access for trucks hauling ballast from the quarry. Due to the gentle slopes, no roadcuts or major fills are anticipated.

ii. Cut slopes (soil/rock)

Existing topographic conditions and anticipated traffic patterns lead us to expect that no significant soil or rock cuts will be required during road construction at this site. See discussion in the previous section.

2. DEPOSIT FEATURES

A. Location (shown on 1:24,000 scale topo to the extent possible; record T, R, Sec)

The center of the 1,800-acre Study Area (Figure A.5-1) is located in the SW/4 sec 6, T13N, R28E (Mineral County, Nevada, Mt. Diablo Meridian).

B. Tonnage (provided in this deposit [W x L x H])

Outcrops in the study area indicate that the proposed quarry pit can support a multiple-bench operation covering about 52 acres with a pit floor at about elevation 4,700 feet. The deposit thickness ranges from 20 to 450 feet and averages about 177 feet (as measured from the assumed pit floor). Quarrying would commence at the top of the deposit. An estimated 33.1 million tons of unprocessed stone is extractable from this deposit.

It should be noted that the steep topography, with average slopes of 30 percent and maximum slopes over 50 percent, might limit the tonnage accessible for quarrying. Extra equipment, such as winches and dozers, may be required to drag the blast hole drills into place.

C. Overburden (note thickness/type)

Surface observations indicate that most of the proposed quarry pit area has no overburden, but could have as much as 5 feet of sandy gravel overburden at higher elevations. Actual thicknesses need to be confirmed with borings. If the overburden is as thin as anticipated, it may be feasible to separate it from the stone by screening the blasted rock rather than removing it mechanically from the bench top prior to drilling.

D. Deposit Features

i. Rock Type/Description (use S&W rock descriptions)

The rock unit of interest in the study area is <u>GRANITE</u>, a high-silica plutonic igneous rock rock composed of quartz and approximately equal proportions of orthoclase and plagioclase feldspars. Plutonic refers to rocks that formed at considerable depths in the earth's crust from magma. Granite cools slowly and develops a medium to coarse crystalline texture. Over time, this pluton was uplifted and exposed by erosion. The granite is bordered to the north by older, metamorphosed, sedimentary rocks and older volcanic rocks.

Multiple thin shear zones exist within the material. These zones are highly fractured and contain sparry calcite. The thickness of the shear zones varies from 1 inch to 1 foot. These shear zones would not make suitable ballast material. In addition, pegmatitic dikes cut the outcrop. These dikes range from a few inches to 2 feet in thickness. The pegmatites contain feldspar, quartz, and micas. They do not appear to significantly weaken the rock in outcrop; however, the extremely coarse grains may be subject to quicker weathering than the finer-grained granite. The granite in the study area was previously mined for construction of the Weber Dam, located approximately 3.2 miles to the northeast, during the 1930s. It is assumed that quarrying would restart at the face of the former quarry operation.

ii. Thickness/Depth (need minable thickness)

Based on a pit floor elevation of 4,700 feet, the maximum thickness of granite within the quarry pit area is about 450 feet. Average thickness is about 177 feet. Determining the actual minable thickness in this steep terrain will require a more detailed subsurface exploration program and engineering study.

iii. Rock Structure (block sizes/joint or fracture spacing)

a. Joints and Fractures

The outcrop is closely jointed and fractured. We noted five distinct joint sets in this outcrop. Average values for each joint set are presented in Table A.5-5.

TABLE A.5-5
JOINT MEASUREMENTS AT SAMPLED OUTCROP MT4010

Joint Set	Dip Angle (degrees)	Dip Direction (azimuth)	Joint Spacing (feet)	
			From	To
J1	69	232	0.50	1.00
J2	70	332	0.25	0.50
J3	44	203	1.00	3.00
J4	22	300	4.00	6.00
J5	67	135	0.50	2.00

b. Estimated block size distribution

Block size distribution is presented in Table A.5-6.

TABLE A.5-6
ESTIMATED BLOCK SIZE DISTRIBUTION AT SAMPLED OUTCROP MT4010

Block Size	Percent Distribution
>6.0 ft	0
4.0 to 6.0 ft	5
2.0 to 4.0 ft	15
0.5 to 2.0 ft	50
<0.5 ft	30

This estimate is also based on visual observation of block size distribution from previous quarry operations at this site.

c. Deleterious Materials, including orientation and thickness (Note: Ash layers/faults/weather contacts, shear zones, fillings, scoriaceous zones, rubble zones, etc. This is internal waste that reduces deposit size.)

Based on observation of surface outcrops, about 10 to 20 percent of this stone could be altered and/or weathered and therefore unsuitable for ballast material (internal waste).

d. Rock Quality Designation (RQD)

Our RQD estimate of the sampled outcrop is 20 to 30 percent. This reflects the closely-spaced jointing of the outcrop.

e. Samples for testing (200 pounds minimum; describe sample; taken)

On 03 November 2006, roughly 220 lbs of rock samples were collected at waypoint MT4010, at various locations between elevation 4,700 and 4,720 feet. The samples filled five canvas bags.

f. Rock hammer test

The granite rock we sampled typically fractures with 15 to 30 blows from a standard geologic rock hammer, indicating high to very high strength.

g. Schmidt-hammer Tests

Ten Schmidt-hammer field tests were performed at the sample collection site. Test results are presented in Table A.5-7. The rocks tested were generally fresh; slight weathering on some test surfaces did not seem to affect the results. During all tests, the instrument was oriented perpendicular to the rock surface.

TABLE A.5-7
WEBER DAM QUARRY SCHMIDT-HAMMER FIELD TEST RESULTS

Test Number	Instrument Reading	Test Surface		Remarks
		Dip Angle	Dip Direction	
1	57	82	100	
2	66	81	219	
3	68	81	219	
4	62	20	305	
5	60	44	274	
6	62	68	234	
7	64	69	232	J1
8	47	22	120	J4
9	62	77	290	
10	62	67	135	J5

iv. Groundwater — Is there evidence groundwater is near surface? Want to avoid groundwater in pit as this causes permitting problem.

No wells or springs were observed within the study area. We saw no evidence of groundwater in the study area. Paiute Spring is located about 0.34 mile south of the southwest corner of the study area. No flowing water was observed here at the time of our visit. We do not anticipate groundwater inflow into the quarry pit during quarry operations. Seasonal surface water inflow should be minimal.

E. Future Explorations

Core drilling is recommended to recover subsurface samples and to characterize the quality of the granite within the proposed quarry pit.

a. Drill rig access

The existing jeep trails are adequate for drill rig access during dry weather.

b. Type of rig

The steep slopes in the quarry pit area will require track-mounted coring rigs (with dozer trails and assistance) for access or helicopter assistance.

c. Locations and depths of borings

A minimum of 10 coring locations are recommended during a preliminary subsurface explorations drilling program. We propose a final quarry floor elevation of 4,700 feet. Each boring should bottom 20 feet below this elevation, or 4,680 feet. These depths range from 60 feet at the north end of the quarry to 390 feet, the highest point on the ridge. The estimate of total required coring is

1,660 feet. If these cores reveal unexpected subsurface conditions (such as variable rock types or rock quality issues), additional coring may be needed to evaluate the quarry pit area.

d. Geophysics alignments

Due to good outcrop exposures, no surface geophysics are anticipated at this time during the preliminary exploration phase.

3. ENVIRONMENTAL FEATURES

A. Vegetation (what type/how much/where)

Vegetation consists mainly of sage, desert grasses, and sparsely scattered Joshua trees, with about 10 to 15 percent ground cover.

B. Visibility (would quarry be visible from road?)

The quarry, plant, spoil stockpile, and siding would be visible from highway US 95A, which runs diagonally through the north half of the study area.

4. OTHER FEATURES

A. Power (is power nearby or need on-site generation)

No existing power was observed in the study area. The distance to existing power is unknown.

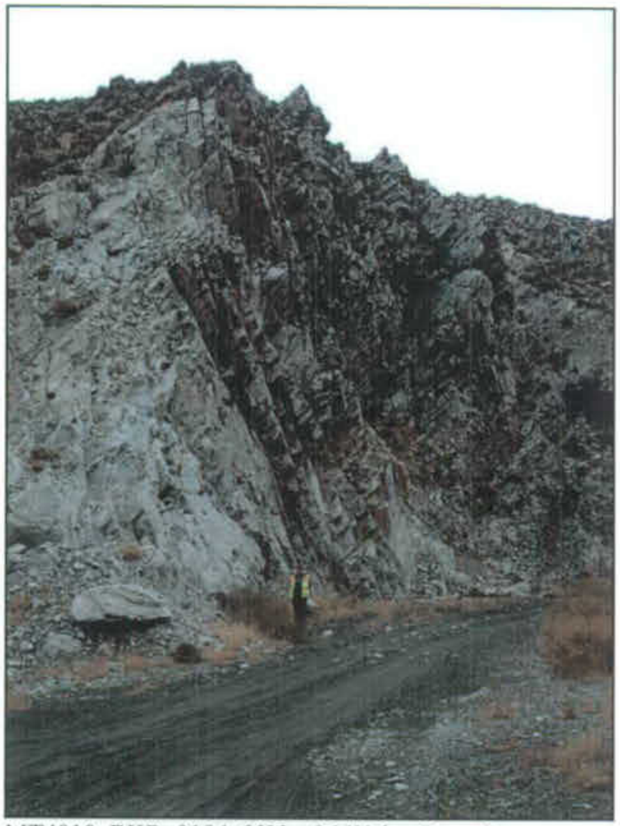
B. Water (groundwater studies by others)

No data available on groundwater studies.

C. Mining Claims/Mining Operations

We observed numerous prospect pits and scattered adits within the study area. We understand, however, that no mining claims exist within the study area. We encountered a few mine claim posts, but they appeared to be inactive at the time of our visit.

5. WEBER DAM QUARRY PHOTOS



MT4010_BKR_0184_03Nov06 Weber Dam Quarry:
View of sampled outcrop; looking S.

MT4010_BKR_0185_03Nov06 Weber Dam Quarry: View of sampled outcrop; looking SE.

MT4010_BKR_0186_03Nov06 Weber Dam Quarry: View of sampled outcrop; looking E.

MT4010_BKR_0187_03Nov06 Weber Dam Quarry: View of sampled outcrop; looking NE.

MT4010_BKR_0188_03Nov06 Weber Dam Quarry: View of sampled outcrop; looking N.

MT4010_BKR_0187_03Nov06 MT4010_BKR_0188_03Nov06 and Weber Dam Quarry: Previous five photos combined in panorama.

APPENDIX B

QUARRY FIELD TEAM BIOSKETCHES

APPENDIX B

QUARRY FIELD TEAM BIOSKETCHES

Field Team (MT4)

(Lead) Bryan "Keith" Rauch is a Senior Engineering Geologist in Shannon & Wilson's St. Louis office, assigned mainly to construction oversight in tunneling projects. Keith has earned a B.S. in Geology from the University of Idaho, College of Mines (1976) and a B.S. in Computer Information Systems from Columbia (MO) College (1999). He is currently pursuing a M.S. in Engineering Management at University of Missouri-Rolla.

For 25 years, prior to joining Shannon & Wilson, Keith held a variety of geologic, engineering and management positions at major producers of base metals, precious metals and industrial minerals. Significant experience and responsibilities include:

- Prepared mine design and development plans at operating mines.
- Prepared ore reserve estimates at operating mines and undeveloped mineral deposits.
- Designed and supervised exploration drilling programs at operating mines.
- Designed and supervised exploration drilling programs for regional exploration projects.
- Supervised production at multi-level underground mining operation.
- Designed experimental blasting patterns, supervised field tests and evaluated results.
- Selected, tested and evaluated mining explosives and detonation systems.
- Monitored blasting vibrations with seismic detection systems.
- Designed, supervised installation, and evaluated results of underground roof support systems.

From 1986 to 1990, Keith held the position of senior geologist with Woodward-Clyde Consultants (now URS) in St. Louis. During this period, he supervised geotechnical investigations and UST removals at sites nationwide.

Elizabeth A. Karcheski is a Geologist III from Shannon & Wilson's Anchorage office. She received her B.S in Geology from California State University, Chico in May of 2003. She joined the staff on Shannon & Wilson after her move to Alaska in July of 2003. The diversity of her projects has given her the opportunity to utilize assorted manners of field exploration ranging from track mounted drill rigs to remote backhoe work. In addition, Ms. Karcheski has performed laboratory analyses, and technical writing for a variety of projects located throughout the State of Alaska. Her field exploration activities have included geotechnical soil borings and surface and subsurface soil sampling, in addition to in situ soil condition testing on projects including the Knik Arm Crossing in Anchorage, Alaska and the Kodiak Rocket Launch Complex in Kodiak, Alaska. Ms. Karcheski also performed field reconnaissance for the Caliente Rail Corridor drill site locations in November 2005.

APPENDIX C

LABORATORY TEST RESULTS

APPENDIX C

LABORATORY TEST RESULTS

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LIST OF SUBAPPENDICES

Subappendix

APPENDIX C

LABORATORY TEST RESULTS

C-1 Specific Gravity/Absorption

The test for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate, American Society for Testing and Materials (ASTM) C 127, is used to determine the average density of a quantity of coarse aggregate particles (not including the volume of voids between the particles), the relative density, and the absorption of the rock sampled at the quarry sites. The relative density or specific gravity is used in calculations for volume and the computation of voids in the material. It pertains to the solid material making up the constituent particles, not including the pore space within the particles that are accessible to water. The American Railway Engineering and Maintenance-of-Way Association (AREMA) standard is that the rock should have a bulk specific gravity more than 2.60 to be suitable as ballast.

Absorption values, obtained by soaking the samples for about 24 hours, are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition. The AREMA standard is that the rock should have an absorption value less than 1.0 percent to be suitable as ballast. This test was performed by Shannon & Wilson, Inc. in its Fairbanks, Alaska, location.

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

SEATTLE
HANFORD
FAIRBANKS
ANCHORAGE
SAINT LOUIS
DENVER

December 2, 2006

Shannon & Wilson, Inc.
400 N. 34th St. Suite 100
Seattle, Washington 98103
Attn: Bill Laprade

RE: 21-1-20102-224 YUCCA MOUNTAIN RAIL ROAD MINA CORRIDOR

This letter is written to submit results of the rock samples delivered to our Fairbanks laboratory. At your request we conducted the following analysis, (ASTM C127 Specific Gravity and Absorption of Coarse Aggregate)

The results are presented below.

Sample Description	Bulk Specific Gravity	Bulk Specific Gravity SSD (Saturated-Surface- Dry)	Apparent Specific Gravity	Absorption
2274 Weber Dam	2.60	2.60	2.61	0.2
2275 Garfield Hills	2.78	2.79	2.82	0.5
2276 North Clayton	2.63	2.64	2.65	0.3
2277 Malpais Mesa	2.75	2.75	2.80	0.7
2278 Gabbs Valley	2.61	2.62	2.63	0.4

If you have any questions regarding the information presented above, please do not hesitate to call.

SHANNON & WILSON, INC.

Alan Vetter, C.E.T.
Laboratory Manager

2355 HILL ROAD
FAIRBANKS, ALASKA 99709
(907) 479-0600 FAX (907) 479-5691

C-2 Degradation (L.A. Abrasion)

The test for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine, ASTM C 535, is used to test material larger than ¾ inch for resistance to degradation. It is a measure of degradation of the mineral aggregates of standard gradings resulting from a combination of actions, including abrasion or attrition, impact, and grinding in a rotating drum containing 12 steel spheres. The rotation and grinding simulate an impact-crushing effect. The AREMA standard is that the rock should have a degradation value less than 25 percent for traprock (basalt) and less than 35 percent for granite to be suitable as ballast.

The test has been widely used as an indicator of the relative quality or competence of various sources of aggregate having similar mineral compositions. The results do not automatically permit valid comparisons to be made between sources of distinctly difference origin, composition, or structure. This test was performed by Ninyo & Moore in its Las Vegas, Nevada, location.

Ninyo & Moore

Geotechnical and Environmental Sciences Consultants

December 8, 2006
Project No. 301530002

Mr. William T. Laprade
Shannon and Wilson
P.O. Box 300303
400 North 34th Street, Suite 100
Seattle, Washington 98103

Subject: Laboratory Test Results

Dear Mr. Laprade:

We have run L.A. Abrasion and Sulfate Soundness tests on samples delivered by your personnel.

Below, please find complete test results.

Quarry Site	L.A. Abrasion	Sodium Soundness
Garfield Hills	14	1.3
Weber Dam Quarry	16	0.4
Malpass Mesa	18	1.3
Gabbs	21	1.2
North Clayton	32	1.5

If you have any questions please contact the undersigned.

Sincerely,
NINYO & MOORE

Fintan L. Gaffney
Principal, Construction Services

FLG/ltk

6700 Paradise Road • Suite E • Las Vegas, Nevada 89119 • Phone (702) 433-0330 • Fax (702) 433-0707
Las Vegas • Irvine • San Diego • Los Angeles • Oakland • Phoenix • Carson City • Ontario

C-3 Sulfate Soundness

The test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate, ASTM C 88, is used to estimate the soundness of aggregates when subjected to weathering action. For this quarry application, sodium sulfate soundness testing is accomplished by repeated immersion in saturated solutions of sodium sulfate followed by oven drying to partially or completely dehydrate the salt precipitated in the permeable pore spaces of the rock sample. The internal expansive force, derived from the rehydration of the salt upon re-immersion, simulates the expansion of water on freezing. The AREMA standard for sodium sulfate soundness is a value less than 5 percent to be suitable as ballast.

Since the precision of this test method is poor, it may not be suitable for outright rejection of aggregates without confirmation from other tests that are related to the use of the aggregate. This test was performed by Ninyo & Moore in its Las Vegas, Nevada, location.

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

December 8, 2006
Project No. 301530002

Mr. William T. Laprade
Shannon and Wilson
P.O. Box 300303
400 North 34th Street, Suite 100
Seattle, Washington 98103

Subject: Laboratory Test Results

Dear Mr. Laprade:

We have run L.A. Abrasion and Sulfate Soundness tests on samples delivered by your personnel.

Below, please find complete test results.

Quarry Site	L.A. Abrasion	Sodium Soundness
Garfield Hills	14	1.3
Weber Dam Quarry	16	0.4
Malpass Mesa	18	1.3
Gabbs	21	1.2
North Clayton	32	1.5

If you have any questions please contact the undersigned.

Sincerely,
NINYO & MOORE

Fintan L. Gaffney
Principal, Construction Services

FLG/ltk

6700 Paradise Road • Suite E • Las Vegas, Nevada 89119 • Phone (702) 433-0330 • Fax (702) 433-0707
Las Vegas • Irvine • San Diego • Los Angeles • Oakland • Phoenix • Carson City • Ontario

C-4 Point Load

The test of Determination of the Point Load Strength Index of Rocks, ASTM D5731 (International Society of Rock Mechanics [ISRM] RTH 325), is used to classify and characterize the rock, based on strength characteristics. Its versatility is that rock specimens can be in the form of rock cores, blocks, or irregular lumps. For this project, irregular lumps were tested. The test is performed by subjecting the rock specimen to an increasingly concentrated load until failure occurs by splitting the specimen. The concentrated load is applied through coaxial, truncated conical platens. The failure load is used to calculate the point load strength index and to estimate the uniaxial compressive strength. There are no AREMA standards for point load testing for ballast.

This test is to be used as an index test for strength classification of rock. The test results should not be used for design or analytical purposes. This test was performed by Shannon & Wilson, Inc. in its Seattle, Washington, location.

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Point Load Testing Summary

ASTM D5731-02/ ISRM RTH 325-89

Project Name: Yucca Mtn, Mina Rt.

Job No.: 21-1-20102-224

Quarry	UCS mean (psi)
Gabbs Range	18700
Garfield Hills	27400
Malpais Mesa South	26400
North Clayton	21700
Weber Dam	30300

Review: SMP/1-8-07

Point Load Test

Lab Data Collection

ASTM D5731-02/ ISRM RTH 325-89

Mina Rt- Gabbs Range

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Project Name: Yucca Mtn, Mina Rt.
Job No.: 21-1-20102-224

Date: 11/30/06
Core Diameter: Irregular Lumps

Test By: SA Reviewed By/On: SMP/1-8-07
Point Load Tester (type/serial no.): GCTS PLT 100

Lab Data									Calculations							
Boring No.	Run No.	Type of Test (D/A/B/L)	Diameter D (inches)	Width W (inches)	Point Load P (kN)	Point Load P (lbs)	Type of Break (I/S/C)	Remarks	De^2 (sq. in.)	Is (psi)	F	Is(50) (psi)	Correlated Core Size	C applied	UCS (psi)
Gabbs	1	L	1.70	2.73	21.39	4809	I		5.91	814	1.10	895	2.43	24.9	22300
	2	L	2.08	3.50	10.33	2322	I		9.27	251	1.22	305	3.04	27.7	8460
	3	L	0.98	2.18	10.84	2437	I		2.72	896	0.92	827	1.65	21.3	17700
	4	L	1.39	2.37	18.61	4184	I		4.19	997	1.02	1010	2.05	23.2	23400
	5	L	2.26	2.74	19.78	4447	I		7.88	564	1.17	662	2.81	26.7	17600
	6	L	1.28	2.21	15.92	3579	I		3.60	994	0.98	977	1.90	22.5	22000
	7	L	1.41	2.40	5.66	1272	I		4.31	295	1.02	302	2.08	23.3	7040
	8	L	1.31	1.90	17.99	4044	I		3.17	1280	0.96	1220	1.78	21.9	26800
	9	L	1.65	1.85	23.06	5184	S	Corner break: technically invalid	~~3.89~~	~~1330~~	~~1.00~~	~~1330~~	~~1.97~~	~~22.8~~	~~30300~~
	10	L	1.27	2.04	13.37	3006	I		3.30	911	0.96	878	1.82	22.1	19400
										High and low results not included in mean					
												Mean:			**18700**

Abbreviations:

Type of Test:
D = Diametral
A = Axial
B = Block
L = Lump

Type of Break:
I = Intact
S = Structure
C = Combined

Calculations:
De^2 = D^2 (diametral test)
De^2 = (4*W*D)/Pi (axial, block, lump test)
F = (De/1.97)^0.45 or (De/2)^1/2, approx.
Is = P/De^2
Is(50) = F*Is
UCS= C*Is(50)

Correction Factor, C:

Core Size (in.)	C (approx.)
0.79	17.5
1.18	19
1.57	21
1.97	23
2.36	24.5

Point Load Test

Lab Data Collection

ASTM D5731-02/ ISRM RTH 325-89

Mina Rt- Garfield Hills

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Project Name: Yucca Mtn, Mina Rt.
Job No.: 21-1-20102-224

Date: 12/04/06
Core Diameter: Irregular Lumps

Test By: SA Reviewed By/On: SMP/1-8-07
Point Load Tester (type/serial no.): GCTS PLT 100

Lab Data											Calculations				
Boring No.	Run No.	Type of Test (D/A/B/L)	Diameter D (inches)	Width W (inches)	Point Load P (kN)	Point Load P (lbs)	Type of Break (I/S/C)	Remarks	De^2 (sq. in.)	Is (psi)	F	Is(50) (psi)	Correlated Core Size	C applied	UCS (psi)
G. Hills	1	L	2.14	2.62	22.85	5137	I	Highly Vesicular (40%)	7.14	720	1.15	826	2.67	26.0	21500
	2	L	2.83	3.59	57.55	12938	I		12.94	1000	1.31	1310	3.60	30.3	39600
	3	L	1.89	2.58	36.95	8307	I		6.21	1340	1.11	1490	2.49	25.2	37600
	4	L	2.02	2.75	17.61	3959	I	Highly Vesicular (40%)	7.07	560	1.14	641	2.66	26.0	16600
	5	L	1.30	2.25	31.34	7046	I		3.72	1890	0.99	1870	1.93	22.6	42300
	6	L	1.52	2.25	21.20	4766	I	Highly Vesicular (40%)	4.35	1090	1.03	1120	2.09	23.3	26100
	7	L	1.52	3.44	33.68	7572	I		6.66	1140	1.13	1290	2.58	25.6	33000
	8	L	2.18	3.35	15.99	3595	I	Highly Vesicular (40%)	9.30	387	1.22	471	3.05	27.8	13100
	9	L	2.19	3.51	32.12	7221	I	Highly Vesicular (40%)	9.79	738	1.23	909	3.13	28.1	25600
	10	L	2.01	2.32	18.73	4211	I		5.94	709	1.10	780	2.44	24.9	19500
										High and low results not included in mean					
												Mean:			27400

Abbreviations:

Type of Test:
D = Diametral
A = Axial
B = Block
L = Lump

Type of Break:
I = Intact
S = Structure
C = Combined

Calculations:

De^2 = D^2 (diametral test)
De^2 = (4*W*D)/Pi (axial, block, lump test)
F = (De/1.97)^0.45 or (De/2)^1/2, approx.
Is = P/De^2
Is(50) = F*Is
UCS= C*Is(50)

Correction Factor, C:

Core Size (in.)	C (approx.)
0.79	17.5
1.18	19
1.57	21
1.97	23
2.36	24.5

Point Load Test **Mina Rt- Malpais Mesa South**

Lab Data Collection

ASTM D5731-02/ ISRM RTH 325-89

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Project Name: Yucca Mtn, Mina Rt.
Job No.: 21-1-20102-224

Date: 12/04/06
Core Diameter: Irregular Lumps

Test By: SA Reviewed By/On: SMP/1-8-07
Point Load Tester (type/serial no.): GCTS PLT 100

Lab Data											Calculations				
Boring No.	Run No.	Type of Test (D/A/B/L)	Diameter D (inches)	Width W (inches)	Point Load P (kN)	Point Load P (lbs)	Type of Break (I/S/C)	Remarks	De^2 (sq. in.)	Is (psi)	F	Is(50) (psi)	Correlated Core Size	C applied	UCS (psi)
Malpais	1	L	1.62	3.34	35.85	8059	I		6.89	1170	1.14	1330	2.62	25.8	[illegible]
	2	L	2.35	3.69	39.30	8835	I		11.0	800	1.27	1010	3.32	29.0	29300
	3	L	2.36	3.96	46.50	10450	I		11.9	878	1.29	1130	3.45	29.6	33400
	4	L	1.91	2.16	8.75	1967	C	Invalid due to weathering	~~5.25~~	~~374~~	~~1.07~~	~~400~~	~~2.29~~	~~24.3~~	~~9710~~
	5	L	2.45	3.00	25.14	5652	I		9.36	604	1.22	736	3.06	27.8	20500
	6	L	1.09	2.07	16.01	3599	I		2.87	1250	0.93	1170	1.69	21.6	25200
	7	L	2.14	3.83	28.66	6443	I		10.4	617	1.25	771	3.23	28.6	22000
	8	L	1.14	3.39	17.24	3876	I		4.92	788	1.05	831	2.22	23.9	[illegible]
	9	L	1.82	2.23	3.86	868	I	Invalid due to weathering	~~5.17~~	~~468~~	~~1.07~~	~~479~~	~~2.27~~	~~24.2~~	~~4330~~
	10	L	2.68	3.00	36.05	8104	I		10.2	792	1.24	985	3.20	28.4	28000
										High and low results [illegible]					
												Mean:			26400

Abbreviations:

Type of Test:
D = Diametral
A = Axial
B = Block
L = Lump

Type of Break:
I = Intact
S = Structure
C = Combined

Calculations:
De^2 = D^2 (diametral test)
De^2 = (4*W*D)/Pi (axial, block, lump test)
F = (De/1.97)^0.45 or (De/2)^1/2, approx.
Is = P/De^2
Is(50) = F*Is
UCS= C*Is(50)

Correction Factor, C:

Core Size (in.)	C (approx.)
0.79	17.5
1.18	19
1.57	21
1.97	23
2.36	24.5

Point Load Test

Lab Data Collection

ASTM D5731-02/ ISRM RTH 325-89

Mina Rt- North Clayton

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Project Name: Yucca Mtn, Mina Rt.
Job No.: 21-1-20102-224

Date: 12/01/06
Core Diameter: Irregular Lumps

Test By: SA Reviewed By/On: SMP/1-8-07
Point Load Tester (type/serial no.): GCTS PLT 100

Lab Data									Calculations						
Boring No.	Run No.	Type of Test (D/A/B/L)	Diameter D (inches)	Width W (inches)	Point Load P (kN)	Point Load P (lbs)	Type of Break (I/S/C)	Remarks	De^2 (sq. in.)	Is (psi)	F	Is(50) (psi)	ed Core Size	C applied	UCS (psi)
Clayton	1	L	2.15	4.06	45.86	10310	I		11.1	928	1.27	1180	3.33	29.1	[illegible]
	2	L	2.19	4.00	43.26	9725	I		11.2	872	1.27	1110	3.34	29.1	32300
	3	L	0.92	2.00	7.67	1724	I		2.34	736	0.89	657	1.53	20.8	13700
	4	L	1.63	2.46	19.73	4436	I		5.11	869	1.06	924	2.26	24.1	22300
	5	L	1.55	2.89	13.95	3136	I		5.70	550	1.09	600	2.39	24.7	14800
	6	L	1.01	2.30	8.79	1976	I		2.96	668	0.94	628	1.72	21.7	13600
	7	L	1.11	2.74	19.17	4310	I		3.87	1110	1.00	1110	1.97	22.8	25300
	8	L	1.15	1.98	10.58	2378	I		2.90	820	0.94	768	1.70	21.6	16600
	9	L	0.73	1.99	9.73	2187	I		1.85	1180	0.85	999	1.36	20.0	20000
	10	L	1.61	2.09	22.6	5081	I		4.28	1190	1.02	1220	2.07	23.3	28400
										High and low results not included in mean					
												Mean:			21700

Abbreviations:

Type of Test:
D = Diametral
A = Axial
B = Block
L = Lump

Type of Break:
I = Intact
S = Structure
C = Combined

Calculations:

De^2 = D^2 (diametral test)
De^2 = (4*W*D)/Pi (axial, block, lump test)
F = (De/1.97)^0.45 or (De/2)^1/2, approx.
Is = P/De^2
Is(50) = F*Is
UCS= C*Is(50)

Correction Factor, C:

Core Size (in.)	C (approx.)
0.79	17.5
1.18	19
1.57	21
1.97	23
2.36	24.5

Point Load Test

Lab Data Collection

ASTM D5731-02/ ISRM RTH 325-89

Mina Rt- Weber Dam

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
400 N 34th St Suite 100, Seattle, WA 98103
Tel: (206) 632-8020 Fax: (206) 633-6777

Project Name: Yucca Mtn, Mina Rt.
Job No.: 21-1-20102-224

Date: 11/30/06
Core Diameter: Irregular Lumps

Test By: SA Reviewed By/On: SMP/1-8-07
Point Load Tester (type/serial no.): GCTS PLT 100

Lab Data											Calculations				
Boring No.	Run No.	Type of Test (D/A/B/L)	Diameter D (inches)	Width W (inches)	Point Load P (kN)	Point Load P (lbs)	Type of Break (I/S/C)	Remarks	De^2 (sq. in.)	Is (psi)	F	Is(50) (psi)	ed Core Size	C applied	UCS (psi)
Weber	1	L	1.84	3.59	30.61	6881	I		8.41	818	1.19	973	2.90	27.1	26300
	2	L	2.07	2.87	31.22	7019	I		7.56	928	1.16	1080	2.75	26.4	28500
	3	L	1.67	2.61	15.52	3489	I		5.55	629	1.08	682	2.36	24.6	16800
	4	L	2.04	2.19	31.76	7140	I		5.69	1260	1.09	1370	2.39	24.7	33900
	5	L	1.18	2.66	22.94	5157	I		4.00	1290	1.01	1300	2.00	22.9	29800
	6	L	2.20	2.90	37.69	8473	I		8.12	1040	1.18	1230	2.85	26.8	33000
	7	L	1.78	2.58	36.58	8224	I		5.85	1410	1.10	1550	2.42	24.9	38500
	8	L	1.52	2.19	29.94	6731	I		4.24	1590	1.02	1620	2.06	23.2	37600
	9	L	1.83	2.23	25.16	5656	I		5.20	1090	1.07	1160	2.28	24.2	28100
	10	L	1.94	4.33	33.39	7506	I		10.7	702	1.26	882	3.27	28.8	25400
										High and low results not included in mean					
												Mean:			30300

Abbreviations:

Type of Test:
D = Diametral
A = Axial
B = Block
L = Lump

Type of Break:
I = Intact
S = Structure
C = Combined

Calculations:

De^2 = D^2 (diametral test)
De^2 = (4*W*D)/Pi (axial, block, lump test)
F = (De/1.97)^0.45 or (De/2)^1/2, approx.
Is = P/De^2
Is(50) = F*Is
UCS= C*Is(50)

Correction Factor, C:

Core Size (in.)	C (approx.)
0.79	17.5
1.18	19
1.57	21
1.97	23
2.36	24.5

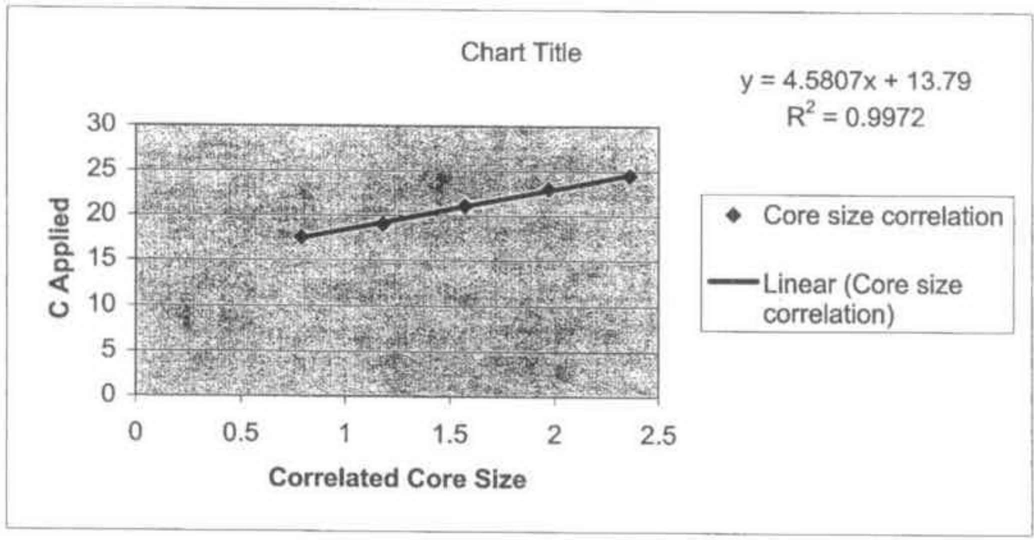

Chart Title
y = 4.5807x + 13.79
R² = 0.9972
C Applied
30
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
Correlated Core Size
Core size correlation
Linear (Core size correlation)

C-5 Total Free Silica

The test of Total Free Silica, ME-ICP 81, is used to determine the percentage of free silica in a rock sample. The test, using fusion assay methods, is used for evaluating the concentrations of specific elements. The results of this test were also shared with Stevens Exploration Management Corp. to aid in their petrographic analysis. There are no AREMA standards for total free silica for ballast.

This test was performed by ALS Chemex, in its Vancouver, British Columbia (BC) location.

ALS Chemex

EXCELLENCE IN ANALYTICAL CHEMISTRY

ALS USA Inc.

994 Glendale Avenue, Unit 3
Sparks NV 89431-5730
Phone: 775 356 5395 Fax: 775 355 0179 www.alschemex.com

To: **SHANNON AND WILSON, INC**
400 N. 34TH ST. STE. 100
PO BOX 300303
SEATTLE WA 98103

Finalized Date: 17-DEC-2006
Account: SHAWIL

CERTIFICATE VA06119379

Project: Yucca Mtn RR, Mina Corridor

P.O. No.: 21-1-20102-224

This report is for 5 Rock samples submitted to our lab in Vancouver, BC, Canada on 22-NOV-2006.

The following have access to data associated with this certificate:

BILL LAPRADE	DON STEVENS	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
CRU-31	Fine crushing - 70% <2mm
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um
CRU-QC	Crushing QC Test

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-ICP81	ICP Fusion - Ore Grade	ICP-AES

To: **SHANNON AND WILSON, INC**
ATTN: BILL LAPRADE
400 N. 34TH ST. STE. 100
PO BOX 300303
SEATTLE WA 98103

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

Signature: R Keith Rogers

Keith Rogers, Executive Manager Vancouver Laboratory

ALS Chemex
EXCELLENCE IN ANALYTICAL CHEMISTRY
ALS USA Inc.
994 Glendale Avenue, Unit 3
Sparks NV 89431-5730
Phone: 775 356 5395 Fax: 775 355 0179 www.alschemex.com

To: SHANNON AND WILSON, INC
400 N. 34TH ST. STE. 100
PO BOX 300303
SEATTLE WA 98103

Finalized Date: 17-DEC-2006
Account: SHAWIL

Project: Yucca Mtn RR, Mina Corridor

CERTIFICATE OF ANALYSIS VA06119379

Sample Description	Method / Analyte / Units / LOR	WEI-21 / Recvd Wt. / kg / 0.02	ME-ICP81 / Si / % / 0.01
Garfield Hills		0.20	23.0
North Clayton		0.04	33.5
Malpais Mesa S		0.12	22.5
Gabbs Valley		0.20	34.2
Weber Dam		0.10	36.1

C-6 Petrographic Analysis

Petrographic analyses were performed on rock samples to determine the rock type and the mineral constituents. The percentage of alteration of the sample was an ancillary characteristic provided by the analyst. Thin sections of the rock samples were prepared by Burnham Petrographics of Rathdrum, Idaho, and the analysis was performed by Stevens Exploration Management Corp. of Anchorage, Alaska. As there is no directly applicable ASTM procedure, the petrographic analysis was performed using methods standard to the mineral exploration industry. They are similar, but not identical to those recommended by the Commission on Standardization of Laboratory and Field Tests established by the International Society for Rock Mechanics. There are no AREMA standards for petrographic analysis or percentage of alteration for ballast.

The mineral percentages from the rock thin sections were obtained by visual estimation utilizing published comparison charts, which is standard practice.

Thin Section Description

Specimen: Malpais Mesa

Rock Classification (IUGS): Porphyritic Leucobasalt

Alteration: Total alteration is about 5%. Most is deuteric alteration of olivine (phenocrysts and groundmass) to iddingsite with some chlorophaeite. Plagioclase phenocrysts show some very minor alteration to calcite (occasional patches) and brown chlorite/chlorophaeite? along fractures.

Hand Specimen: Not available

Silica Analysis: 22.5% Si (48.1% SiO_2)

Thin Section: (Stained for K-feldspar).

Plagioclase: 78% (including 40%? labradorite phenocrysts). Phenocrysts range from <0.5 to 5.5 mm with common size range 1.2-2.8 mm; occasional grains are composite; some zoned; some have cores with cellular structure. Groundmass plagioclase laths range from about 0.06 to 0.50 mm with 0.08 to 0.35 mm most common. Phenocrysts are euhedral to subhedral with albite (and some Carlsbad) twinning present but not abundant. The plagioclase has a biaxial interference figure with 2V near 90°. Alteration is slight, to chlorite/chlorophaite, clays and opaques. Some plagioclase phenocrysts contain inclusions of augite and apatite.

Olivine: 7% (including 4%? phenocrysts); biaxial, 2V ~ 90°, optic sign indeterminate. Phenocrysts ~ 0.25-2.5 mm in diameter; euhedral to subhedral, polygonal shape; upper 2nd order birefringence; high relief. Iddingsite rims the phenocrysts and some of the larger olivine grains in the groundmass. (Some groundmass olivine grains are completely replaced by iddingsite.) Serpentine/ chlorphaeite also partially replaces some olivine in phenocrysts and groundmass.

Opaques/Magnetite: (7%) Euhedral to subhedral cubic and other octahedral forms, usually about ~ 0.05 mm, up to 0.25 mm. The opaques here are usually individual grains homogeneously distributed throughout the groundmass. Some chromite may be included here.

Pyroxene: Augite?: (2%?) Confined to groundmass; occurs as short prismatic, colorless to slightly greenish (in plane light), high relief crystals, with 1st order interference colors and extinction angle ~ 45°. The augite is basically unaltered, with size ranging from <0.05 to 0.10 mm. Occurs in small clumps or as individual grains finely disseminated.

Biotite: (1%) Typical parallel "crinkly" extinction; pleochroism, moderately red- to yellow-brown to light brown; grains 0.2 to 0.35 mm long. Some unidentified yellow-brown (Fe-oxides?) in the groundmass and along fractures and seams in phenocrysts may be incipient biotite-?

Apatite: (<<1%) Small, colorless, high relief grains with 1st order gray interference colors.

Iddingsite: (5%) Reddish-brown mineral with lamellar structure, high relief and high birefringence (when not obscured by the strong color). Iddingsite rims the olivine phenocrysts and occurs along fractures within the olivine. It also totally replaces many of the small olivine grains in the groundmass. (Some of the iddingsite may actually be hematite-colored serpentine.) Iddingsite is considered to be deuteric.

Calcite: (<1%) Colorless, high relief grains with extreme ("pearlescent") birefringence; occurs in occasional small (~ 0.3 mm) patches and thin seams (along with serpentine and chlorite-chlorophaeite) in plagioclase phenocrysts and as microfracture fillings.

Microfracturing: Phenocrysts are invariably fractured within, but rarely extend beyond the grain boundaries. Microfractures in the groundmass are very rare.

Fabric: Texturally, this is a porphyritic rock with an intergranular groundmass/matrix. There is a very crude alignment of the plagioclase laths in the groundmass of this specimen. There was no alignment noted among the phenocrysts.

Summary

This volcanic rock is classified as a **Porphyritic Leucobasalt** on the basis of mineralogy determined through petrographic examination and the chemically determined silica content (22.5%; 48.1% SiO_2). The color index (of the thin section) is about 17, which is low for a basalt; therefore, the "leuco" designation applies by IUGS standards. The total phenocryst content is approximately 45%, with approximately 85% of these being plagioclase. The sample is composed of plagioclase (78%) with minor olivine (7%), magnetite/opaques (7%), augite (2%), biotite (1%) and apatite (<<1%). Iddingsite (5%), a deuteric alteration product, is the most notable secondary mineral, with serpentine, chlorite/chlorophaeite, Fe oxides(?) and calcite present in minor amounts. This is, overall, a relatively unaltered rock.

Petrographer: Carolyn C.H. Stevens
Carolyn C.H. Stevens M. S.

Approved by: Donald L. Stevens
Donald L. Stevens Ph. D., CPG

Date: December 20, 2006

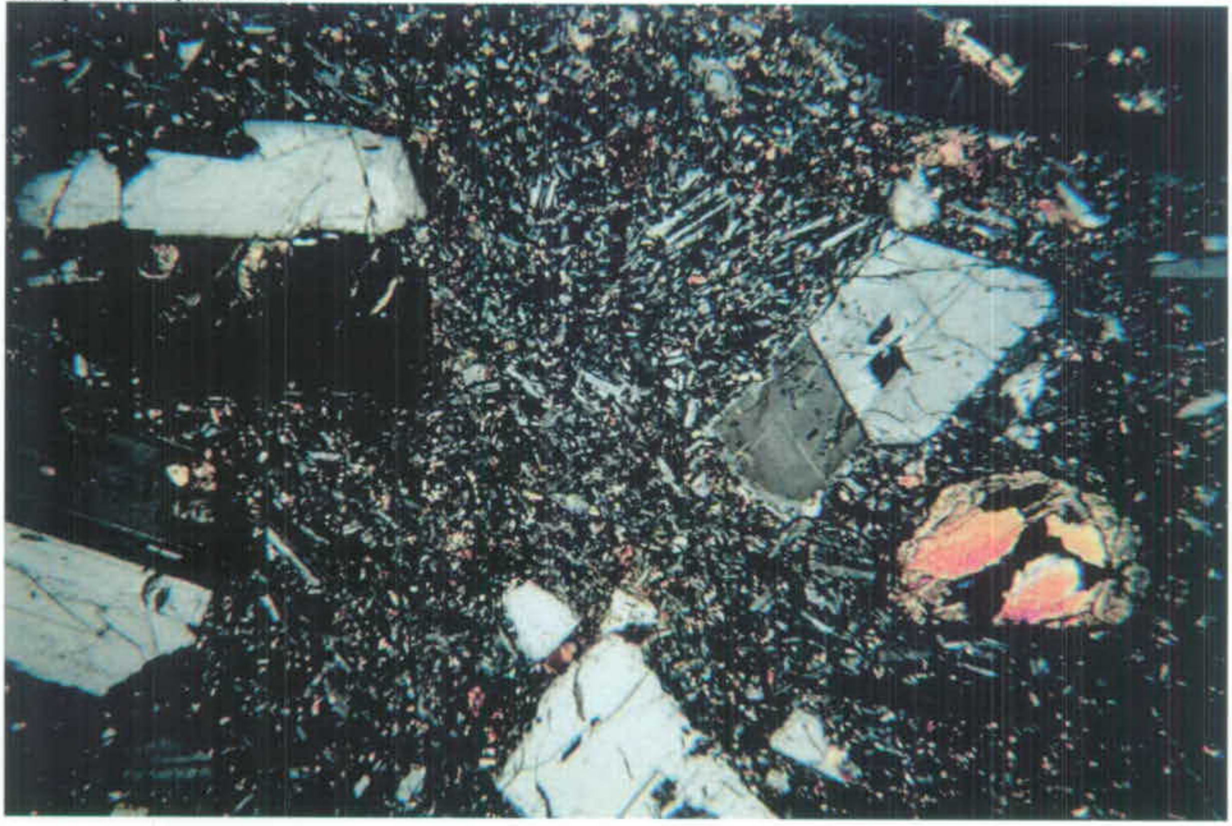

Figure 1 View of Malpais Mesa thin section with crossed polars. Width of this view is about 5 mm.

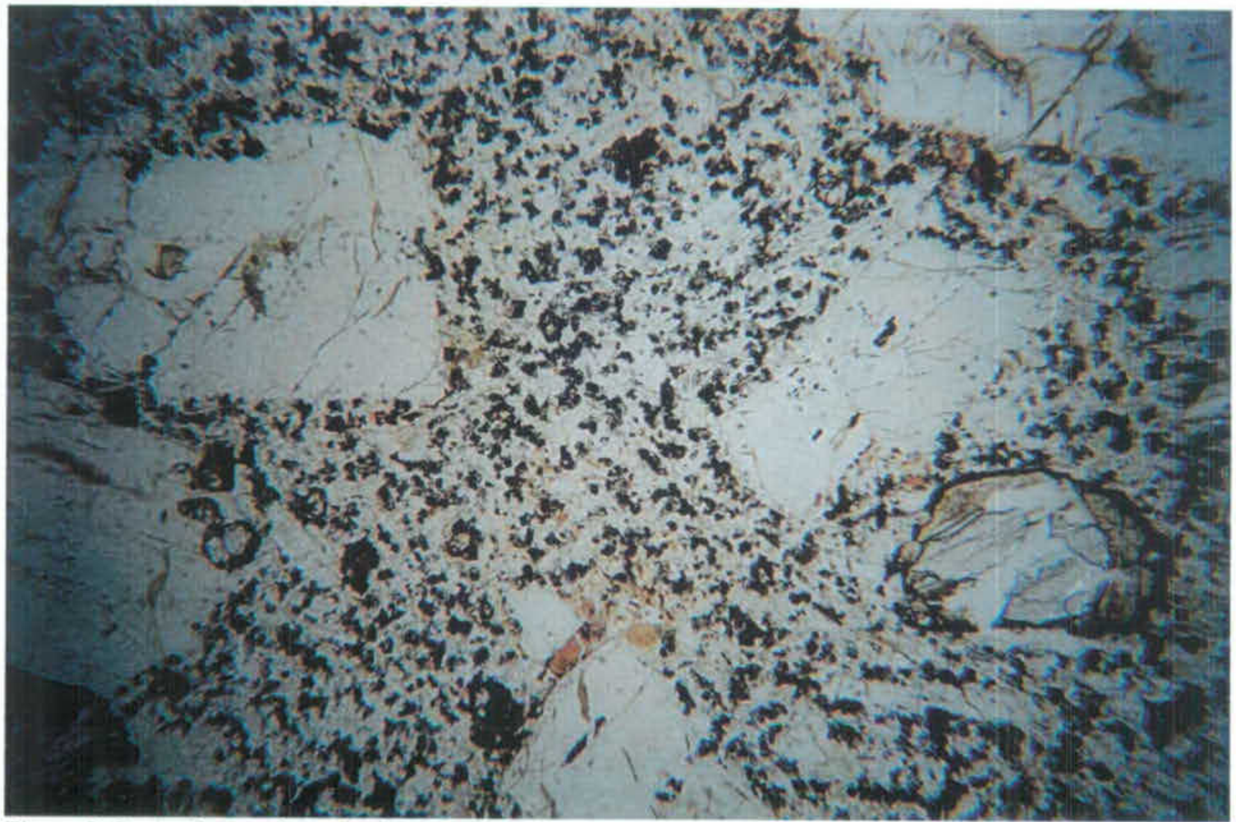

Figure 2 Same view as above but in plane polarized light.

Thin Section Description

Specimen: North Clayton

Rock Classification (IUGS): Granite

Alteration: The potassium feldspar is usually moderately altered to kaolinite. Calcic cores of plagioclase are commonly deuterically altered, then enclosed by later shells of (unaltered) more alkalic plagioclase.

Hand Specimen: Not provided

Silica Analysis: 33.5% Si (71.7% SiO_2)

Thin Section (Stained for K-feldspar)

Quartz: (42%) Anhedral grains, often with strained extinction, range in size from to < 0.1 mm. to ~ 1.5 mm. Commonly occur as optically continuous patches enclosing smaller grains of biotite, feldspars, and smaller quartz grains. The quartz is late and interstitial.

Potassium Feldspar: (32%) Stained very light yellow; subhedral to anhedral grains < 0.10 to 2.5 mm; usually moderately altered to fine-grained kaolinite ("milky" in reflected light); commonly microperthitic.

Plagioclase: (16%) An_{15} (oligoclase), euhedral to subhedral grains with typical albite twinning; < 0.25 mm to ~ 3.5 mm long. About 2/3 of the larger grains are zoned, with ~ ¼ of these having highly altered (clay/sericite/calcite) cores. The altered, zoned plagioclase suggests that earlier more calcic plagioclases were deuterically altered and later rimmed by more alkalic feldspar.

Biotite: (5%) Larger (~1.2 mm or less) individual biotite grains appear to be degrading, while the smaller (0.5 mm or less) biotite grains appear fresh. In several places, a mosaic of variously-oriented biotite grains (with granular opaques and chlorite) partially or completely replaces hornblende. One of these biotite-replaced hornblende grains is 5 mm. long. Some finger-like outgrowths from biotite into orthoclase and graphic intergrowths of biotite and quartz are present in myrmekite texture. The fresh biotite is apparently developing from potassium feldspar.

Opaques: (3%) magnetite < 0.01 up to 0.80 mm. diameter; anhedral to subhedral grains (and some fine opaque needles) are usually associated with biotite and chlorite.

Chlorite: (3%) Purplish (i.e."Berlin blue" anomalous interference colors) pennine with radial habit, green in plane light, pleochroic to pale yellow; often associated with opaques and/or biotite.

Muscovite: (<1%) Colorless shreds 0.10 mm or less with perfect parallel "crinkly" extinction and upper 2nd order birefringence.

Calcite: (<1%) Very high relief and "pearlescent" interference colors; occurs interstitially and as an alteration product of plagioclase (especially in the more calcic altered cores of zoned grains) and sometimes as an alteration product of the mafics.

Zircon: (<<1%) Very high relief; colorful (2nd order) polygonal to oblong-shaped grains < 0.20 mm. long.

Apatite: (<<1%) High relief, low 1st order gray interference colors <0.15mm.

Rutile: (<<1%) Reddish needles

Microfracturing: Discontinuous microfractures filled with brownish granular (Fe oxides?) material are about 3.5 mm long, maximum. Though rare, several are present in the rock fabric.

Fabric: Grain sizes in this rock are more bimodal than seriate, so the texture could be considered porphyritic. No particular orientation of minerals was noted in the fabric. Like many granites, however, the plagioclase and mafics are generally euhedral, while potassium feldspar is subhedral to anhedral, and quartz is anhedral.

Summary

This hypabyssal intrusive rock is classified as a **granite** on the basis of its mineralogy (estimated percentages) determined through petrographic analysis and the chemically determined silica content (33.5% Si; 71.7% SiO_2) using the IUGS classification. (An old standby for this petrographer, the "Descriptive Modal Classification of Igneous Rocks" by Donald W. Peterson, was also a reference.) The sample is composed of quartz (42%), potassium feldspar (32%) and plagioclase (16%), with minor biotite (5%), opaques (3%) and chlorite (3%), and accessory muscovite (<1%) and calcite (<1%). Zircon, apatite, and rutile are also present, but in very accessory (<<1%) amounts.

Quartz and potassium feldspar are occasionally intergrown, yielding micrographic textures within the adjacent potassium feldspar. Some finger-like outgrowths from biotite into orthoclase and graphic intergrowths of biotite and quartz are present in myrmekitic texture. Fresh biotite is apparently developing from the potassium feldspar. (Development of biotite from potassium feldspar is most abundant in contaminated granites in which basic materials are assimilated.) This rock, therefore, is considered to be a contaminated granite in this report. Despite the contamination and alteration, this is a relatively fresh rock.

Petrographer: Carolyn C. H. Stevens
Carolyn C.H. Stevens M. S.

Approved by: Donald L. Stevens
Donald L. Stevens Ph. D., CPG

Date: December 20, 2006

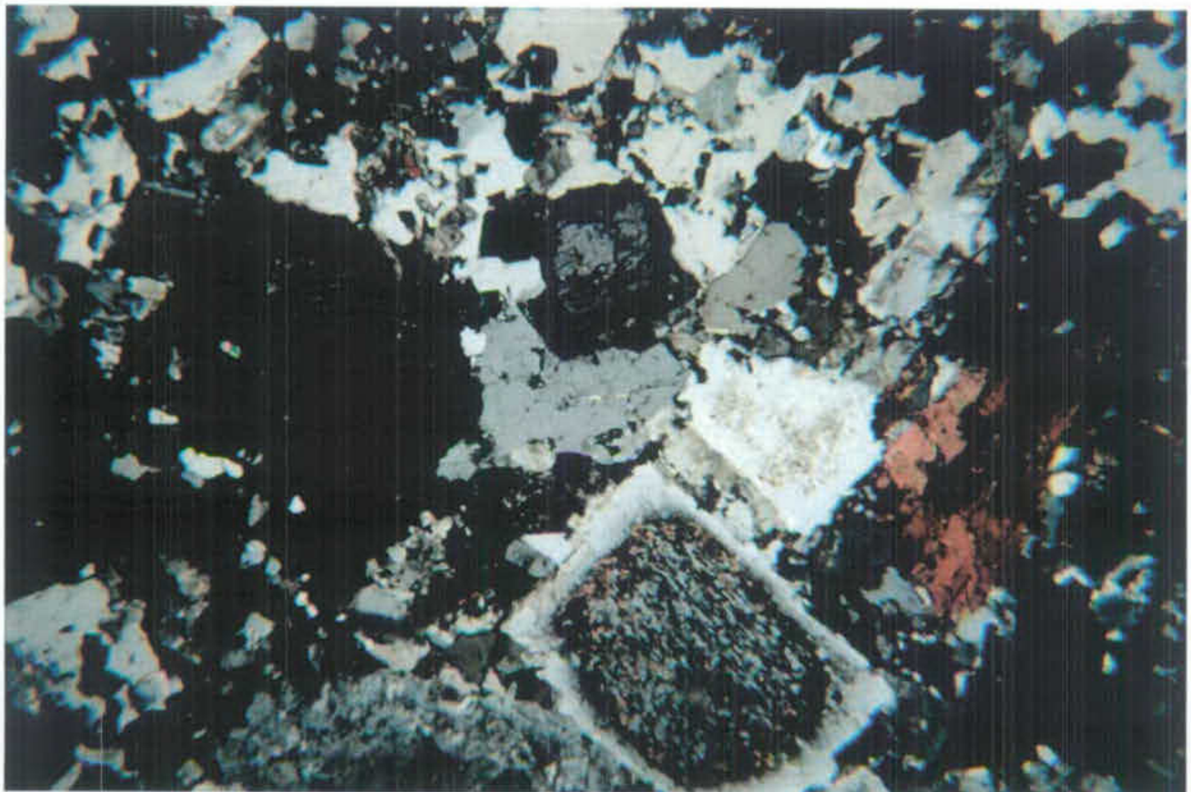

Figure 1 View of North Clayton thin section with crossed polars. Width of this view is about 5 mm.

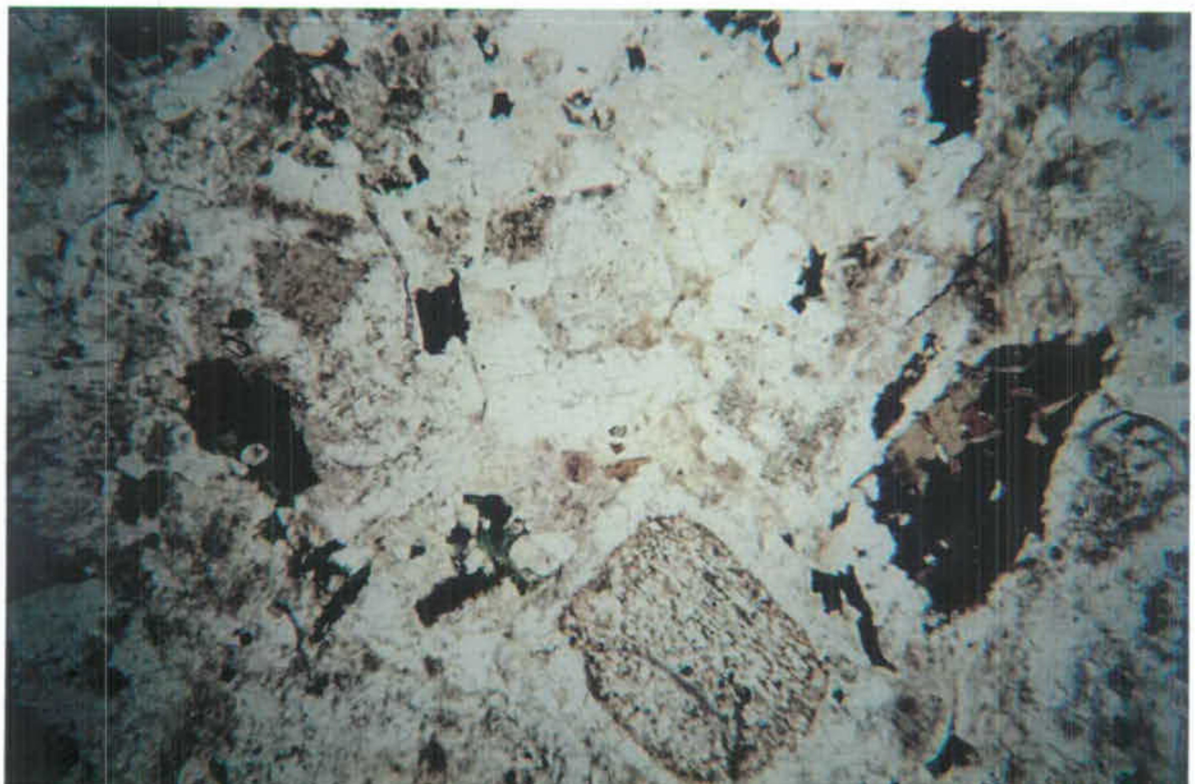

Figure 2 Same view as above but with plane polarized light.

Thin Section Description

Specimen: Gabbs Valley

Rock Classification (IUGS): Granite

Alteration: Potassium feldspar, in particular, and plagioclase are slightly to moderately altered to fine-grained kaolinite ("milky" in reflected light).

Hand Specimen: Not provided

Silica Analysis: 34.2% Si (73.2% SiO_2)

Thin Section (specimen stained for K-feldspar)

Quartz: (43%) Anhedral grains and composite patches range from < 0.07 to 5.0 mm; larger grains in particular commonly show strained extinction, display 2 sets of microfractures at ~ right angles, and contain altered K-spar patches. Grain boundaries between adjacent quartz and feldspars are typically sutured and embayed. Annealed smaller grains along larger grain boundaries suggests granulation. Microfractures through quartz grains are emphasized/displayed by trains of minute chlorite?/biotite? grains. Much of the smaller quartz is granular and/or interstitial.

Potassium Feldspar: (35?%) Subhedral to anhedral grains (< 0.05 to 6.5 mm) typically have sutured and embayed grain boundaries along which much finer grains of quartz and feldspar occur, giving the boundaries of larger grains a granulated annealed appearance. Microperthite is common in these potassium feldspars, and an occasional (yellow-stained) K-feldspar grain is rimmed with albite? (unstained). Potassium feldspar here includes some "tartan"-twinned microcline. K-spar is slightly to moderately altered to kaolinite ("milky" in reflected light).

Plagioclase: (15?%) Oligoclase (An_{28}), euhedral to anhedral (most commonly suhedral) <1.2 mm to 3 mm. long. Albite twinning; less altered (to clays) than the K-feldspar; some composite grains with twinning in varying directions; cores are often more altered (to clay?) than rims.

Opaques: (2%) Magnetite grains range from < 0.10 mm to 1 mm; zircon, apatite and sphene may be associated. The opaque grains are usually anhedral and appear to be interstitial. Also occur as individual grains and in association with the alteration of mafics.

Biotite: (1%) Subhedral to anhedral grains 0.6 to 1.7 mm; greenish-brown in plane light, pleochroic to yellow-green; zircon? sphene? inclusions display radioactive haloes (3 in one grain!); typical perfect, parallel cleavage and "crinkly" extinction when the grain is appropriately oriented. Occurs interstitially and in association with hornblende as an alteration product. What appears to be "Fe oxides" may be incipient biotite or chlorite.

Hornblende: (1%) Euhedral to subhedral grains 0.5 mm to 1.7 mm; cross-sections with typical hornblende cleavage; "twinned" in one longitudinal section; extinction angle ~

18°; pleochroic from med. green to pale yellow-green. Some hornblende grains are partially altered to biotite and opaques.

Sphene: (2%) Several large sphene grains occur in this specimen. Grains range from <0.20 to 1.5 mm. in length, with several being 0.75 mm or larger. They have extreme relief and extreme birefringence, and at least one grain is cored with skeletal ilmenite surrounded by leucoxene. Some grains are slightly pleochroic, and several display the angular rhombic shape and prominent parting that is typical of well-developed sphene.

Apatite: (<<1%) Occurs as small (<0.15 mm) high relief grains with 1st order gray birefringence.

Chlorite: (<<1%) Some of the chlorite is pennine chlorite, with the anomalous "Berlin blue" interference colors. The chlorite in this specimen is very minor, and associated with the alteration of the mafics.

Zircon: (<<1%) Small, very high relief colorful grains associated with altered mafics.

Microfracturing: There are some microfractures in this specimen. The large quartz grains, in particular, are fractured in rectangular patterns (2 perpendicular sets). Some other microfractures cut across the rock fabric for ~ 6 mm but are not continuous. Fractures are often emphasized by Fe-oxides/incipient biotite? or chlorite?

Fabric: No particular orientation of minerals was noted in the fabric of this specimen. The larger quartz and potassium feldspar grains might suggest a porphyritic texture, but grain sizes are more gradational than bimodal.

Summary

This hypabyssal intrusive rock is classed as a **granite** based on the mineralogy (estimated percentages) determined through petrographic analysis and the chemically determined silica content of 34.2% Si (73.2% SiO_2). Color index is ~ 5%. The sample is composed of quartz (43%), potassium feldspar (35%), plagioclase/oligoclase (15%), opaques (probably mostly magnetite - 2%), biotite (1%), hornblende (1%), sphene (2%), and accessory apatite, chlorite and zircon. The texture of the specimen is hypidiomorphic granular, i.e. the hornblende and plagioclase tend to be euhedral to subhedral, the potassium feldspar subhedral to anhedral, and the quartz anhedral. The rock displays seriate texture in the wide range of gradational grain sizes. No preferred orientation was noted in the minerals.

Potassium feldspar, in particular, and some of the plagioclase is moderately (deuterically) altered to fine-grained kaolinite. (Microperthitic textures, however, are preserved.) Most of the sparse hornblende grains are partially altered to biotite and opaques. Some of the biotite and opaque grains, however, appear to be primary and interstitial. This is a relatively unaltered rock.

Petrographer: Carolyn C.H. Stevens
Carolyn C.H. Stevens M. S.
Approved by: Donald L. Stevens
Donald L. Stevens Ph. D., CPG
Date: December 20, 2006

Figure 1 View of Gabbs Valley thin section with crossed polars. Width of this view is about 5 mm.

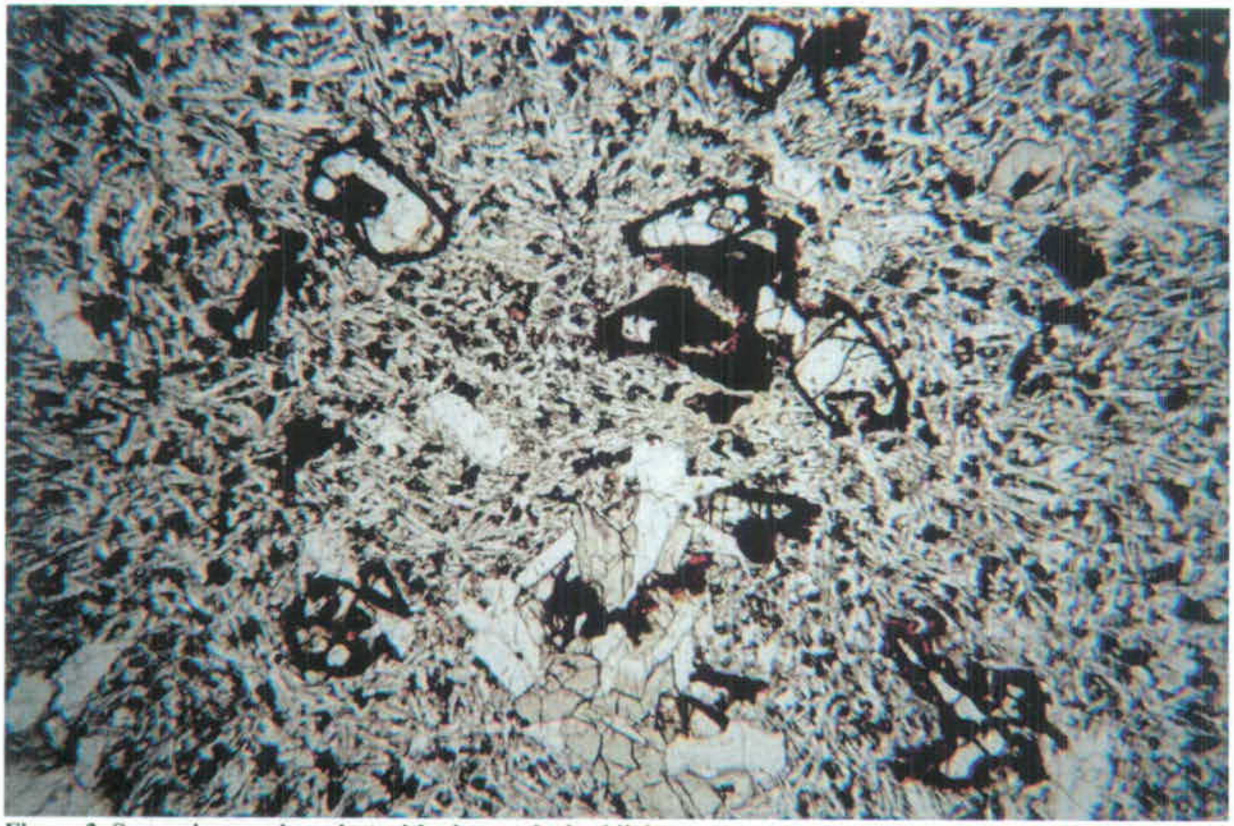

Figure 2 Same view as above but with plane polarized light.

Thin Section Description

Specimen: Garfield Hills

Rock Classification (IUGS): Basalt

Alteration: The colorless olivine is somewhat altered deuterically to iddingsite (rims and internal fractures). Except for small, rather rare patches of calcite as a very minor alteration product of plagioclase, the deuteric alteration of the more abundant of the colorless olivine to deep reddish-brown iddingsite is the only alteration evident. The strong reddish-brown color and relative abundance (9?%) of the iddingsite lends a mottled rusty cast to the specimen. Neutral-colored olivine is unaltered. Very minor serpentine was also noted.

Hand Specimen: Not available

Silica Analysis: 23.0% (49.2% SiO_2)

Thin Section (Specimen stained for K-feldspar)

Plagioclase: 54% (including 5% phenocrysts); euhedral to subhedral labradorite laths 0.5 to 1.4 mm long; some zoned. Plagioclase (andesine) laths in groundmass average ~ 0.2 mm long and are crudely aligned due to flow banding.

Olivine: 20% (including 8% phenocrysts); phenocrysts <0.5 to 4.0 mm long with average ~ .75 mm; groundmass grains ~ 0.08 mm diameter. There may be two chemically distinct olivines. About two-thirds of the total olivine is rimmed with iddingsite. The remaining (neutral-colored) third is unaltered. The iddingsite-rimmed olivine is biaxial with a 2V~ 85° with (+?) sign, colorless in plane light, and displays (anomalous?) 3rd order interference colors. The remaining olivine is unaltered and has a 2V ~ 60° with (+) sign, is neutral in plane light, is non-pleochroic and is commonly zoned and occasionally twinned. Olivine, both altered and unaltered, occurs as phenocrysts and as groundmass constituents.

Clinopyroxene, Augite: (3-4%); intergranular in groundmass; colorless to faint greenish-yellow or brown (Fe- or iddingsite-stained?) prisms and rounded grains; 1st to low 2nd order interference colors; prisms have ~ 45°extinction angle.

Iddingsite: (9%); Deep red-brown to yellowish-brown with typical lamellar structure; high relief. Occurs as rims on, and replacements of, the colorless olivine. Iddingsite, a deuteric mineral, appears to be further altered sometimes to Fe oxides. Very minor patches of serpentine were also noted.

Opaques: (5%?) Mostly magnetite with perhaps some chromite, ilmenite with leucoxene and hematite. The strong color of the relatively abundant iddingsite masks the identity of some of these opaque and semi-opaque groundmass minerals.

Calcite: (<1%) Occurs as small patches and grains in the groundmass as an alteration product of plagioclase. High relief and "pearlescent" interference colors are typical calcite characteristics.

Other: (<< 1%) Small (~ 0.05 mm) grains of sphene (very high relief, very strong birefringence) and apatite? (colorless, high relief, 1st order gray birefringence) occur as accessories in the groundmass.

Microfracturing: No microfractures were noted in this rock.

Fabric: Groundmass plagioclase laths display alignment due to flow banding in this porphyritic volcanic rock.

Summary

This volcanic rock is classified as a rather fine-grained porphyritic basalt on the basis of the (estimated) mineral percentages in this petrographic analysis, and on chemically determined silica content (23.0%; 49.2 SiO_2). Phenocrysts comprise about 13% of this rock, with more than half of the phenocrysts being olivine and the scant half being plagioclase. The phenocrysts occur in an intergranular flow-banded groundmass of plagioclase laths (60%), granular olivine (6%), pyroxene-augite (7%), opaques (9%=magnetite plus chromite, ilmenite and hematite) and accessory minerals (sphene and apatite).

One very interesting feature of this rock is the differing alteration state of the olivine(s), which occur both as phenocrysts and as granular groundmass constituents. Colorless olivine is somewhat altered deuterically to iddingsite (rims and along internal fractures). Olivine that is neutral in plane light is commonly zoned and twinned. Both lack cleavage (or have very poor cleavage) and display the high relief and irregular fractures characteristic of olivine. However, the alteration difference is probably due to chemical variations of the olivine(s).

Except for small, rather rare patches of calcite as a very minor alteration product of plagioclase, the deuteric alteration of the more abundant colorless olivine to deep reddish-brown iddingsite is the only alteration evident. Colorless olivine phenocrysts are rimmed with iddingsite, and colorless olivine grains in the groundmass are either rimmed or replaced with iddingsite. The strong reddish-brown color and relative abundance (9?%) of the iddingsite lends a mottled rusty cast to the specimen. Neutral-colored groundmass olivine grains are, like the neutral phenocrysts, unaltered. Very minor serpentine was also noted.

No microfractures were noted.

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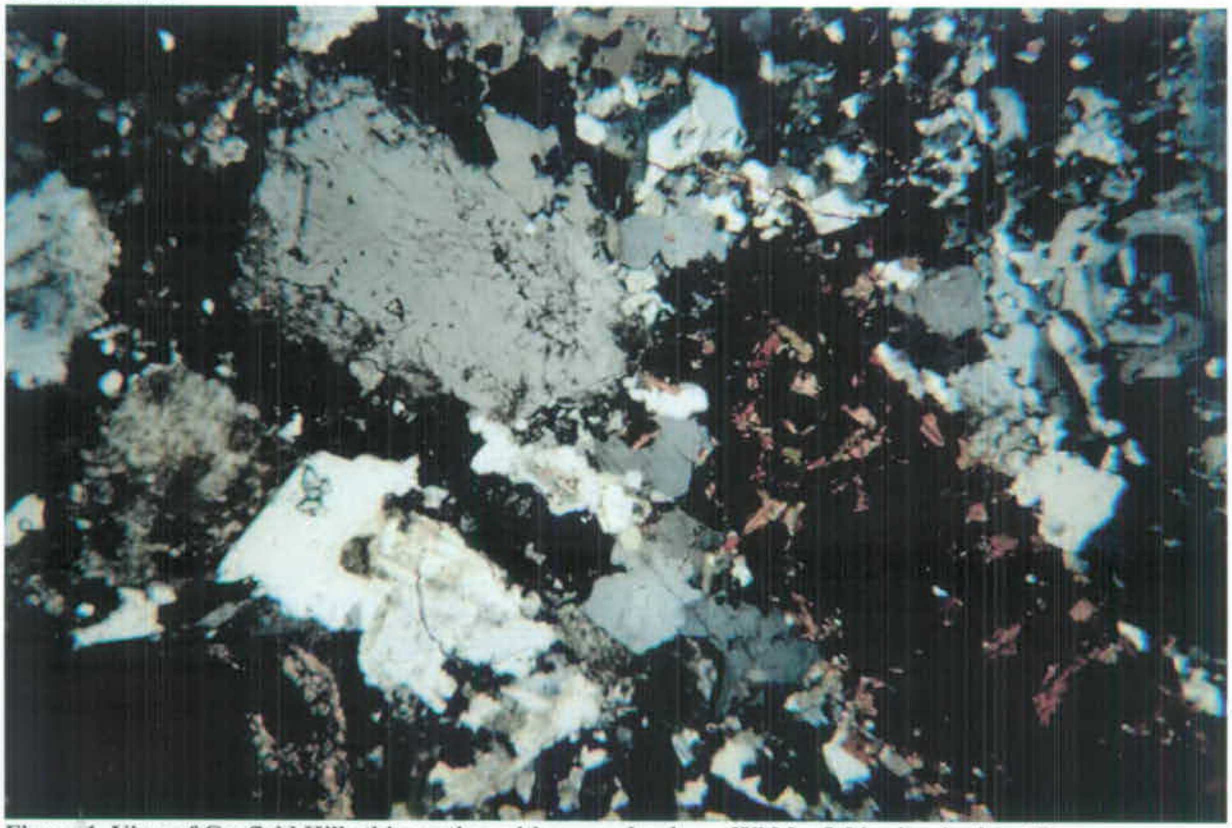

Figure 1 View of Garfield Hills thin section with crossed polars. Width of this view is about 5 mm.

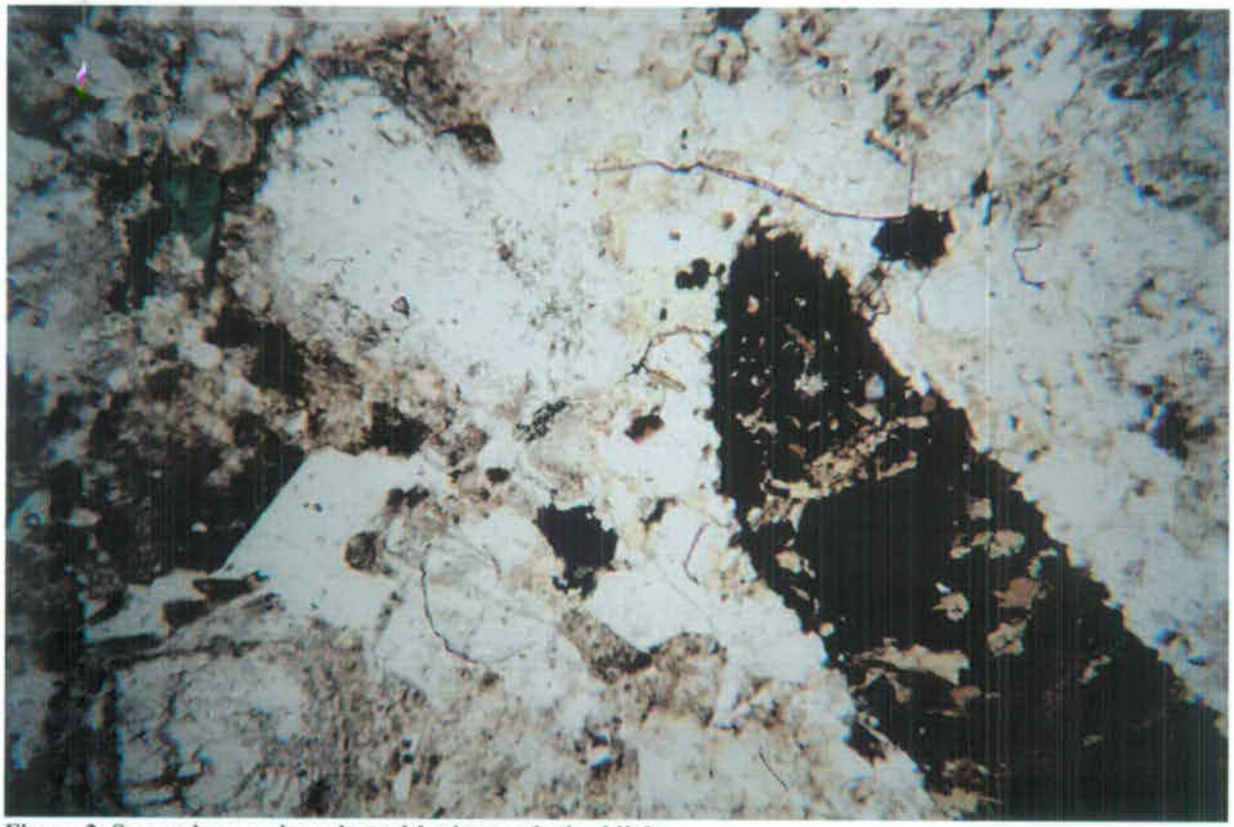

Figure 2 Same view as above but with plane polarized light.

Thin Section Description

Specimen: Weber Dam

Rock Classification (IUGS): Granite

Alteration: Some of the potassium feldspar is moderately altered to kaolinite; plagioclase feldspar is moderately altered to fine needles of an unidentified mineral, plus some sericite and fine-grained clinozoisite. Accessory hornblende and minor biotite are moderately altered to chlorite and opaques.

Hand Specimen: Not provided.

Silica Analysis: 36.1% Si (77.2% SiO_2)

Thin Section (specimen stained for K-feldspar)

Quartz: (34%) Anhedral, often composite, grains range from < 0.2 to 3.5 mm; ubiquitous strained extinction; grain boundaries sutured and embayed. Streaks of minute opaques and very fine bubble trains criss-cross the quartz. The smaller quartz grains are granular or interstitial.

Potassium Feldspar: (32%) The yellow staining for K-spar was particularly effective in this specimen. Subhedral to anhedral grains (< 0.15 to 3.0 mm) typically have sutured and embayed grain boundaries; finer grains of quartz and feldspar between larger grains suggest annealed granulation. Microperthite is common in these potassium feldspars; some "tartan"-twinned microcline was noted. Most K-spar is mildly to moderately (deuterically) altered to kaolinite ("milky" in reflected light). Myrmekitic intergrowths between adjacent grains of K-feldspar and plagioclase are not uncommon and project from the plagioclase into the K-feldspar.

Plagioclase: (28%) This feldspar (oligoclase: An_{26} biaxial negative with $2V \sim 85°$; often not twinned or only vaguely twinned) did not accept the potassium feldspar stain. Colorless in plane light, it is moderately altered to high relief, fine-grained needles of (?) plus some sericite and fine-grained clinozoisite. An occasional crystal has typical albite twinning. Rarely euhedral, most are subhedral to anhedral grains <0.7 to 1.5 mm long. In a few plagioclase grains, bleb-like inclusions of quartz and potassium feldspar (antiperthite?) in the host may indicate regional metamorphism.

Opaques: (1%) Hematite is subhedral, black in reflected light with red translucent edges. Some magnetite and ilmenite with leucoxene rims are present. Opaque grains range from < 0.10 to 1.5 mm long.

Clinozoisite: (1%) Grains (<0.5 to 1 mm. long) have high relief, and are colorless in plane light; characteristic blue and yellow (anomalous) interference colors.

Biotite: (1%) Grains are 0.75 to 0.35 mm. long, and have med. yellow-brown to light yellow pleochroism, and perfect parallel "crinkly" extinction. Sometimes interleaved with muscovite and/or chlorite.

Chlorite: (1%) Interference colors of grains are bronze to "Berlin" blue (anomalous); pleochroic from moderate emerald green to pale yellow (almost colorless). Associated with muscovite and biotite.

Muscovite: (1%) Grains show upper 2nd order interference colors with typical perfect cleavage and parallel "crinkly" extinction; colorless in plane light, some with faint green pleochroism; (< 0.07 to 0.5mm). Commonly associated with chlorite and biotite.

Epidote/pistacite: (< 1%) Grains < 0.01 to 0.2 mm long; light (pistachio) green to almost colorless in plane light, sometimes slightly pleochroic; has high relief and middle 2nd order interference colors. Usually associated with chlorite and muscovite.

Hornblende: (<<1%) One zoned, twinned grain ~ 0.25 mm. long was noted.

Apatite: (<<1%) Small euhedral high relief grains with 1st order gray birefringence.

Microfracturing: Only one microfracture (~ 1.5 mm long) was noted; it was filled with an opaque mineral.

Fabric: This hypabyssal(?) intrusive granite has typical hypidiomorphic-granular texture. The sample is mostly composed of anhedral quartz, subhedral to anhedral potassium feldspar and euhedral (rare) to anhedral plagioclase (oligoclase) in about equal amounts with very subordinate opaques and (usually euhedral to subhedral) biotite, chlorite and hornblende. No preferred orientation of any minerals was noted. Some myrmekitic textures are present.

Summary

This hypabyssal leucocratic intrusive is classified as a **granite** based on the mineralogy (estimated percentages) derived through petrographic analysis and determined silica content (31.6%; 77.2% SiO_2). Color Index of this specimen is 2-3%. The sample is composed of quartz (34%), potassium feldspar (32%), plagioclase (28%), and minor amounts of opaques (1%), clinozoisite (1%), biotite (1%), chlorite (1%), muscovite (1%), and accessory epidote/pistacite (<1%), hornblende (<<1%) and apatite (<<1%). The rock displays typical granitic texture (i.e. hypidiomorphic-granular texture) with the plagioclase tending to be euhedral to subhedral, potassium feldspar subhedral to anhedral, and the quartz anhedral. No preferred orientation of any minerals was noted in this slide and most microfractures are confined to the quartz, not extending beyond the grain boundaries. One short (~ 2.5 mm long), discontinuous, opaque-filled microfracture between grains was noted in one place on the slide.

Many of the feldspar grains are slightly to moderately altered to kaolinite, giving those altered grains a "dusty" appearance in plane light. Feldspars constitute 60% of the rock, and almost all the feldspar is slightly altered. However, only about 15% of the total feldspar content is "moderately" altered; therefore, this is a relatively fresh rock.

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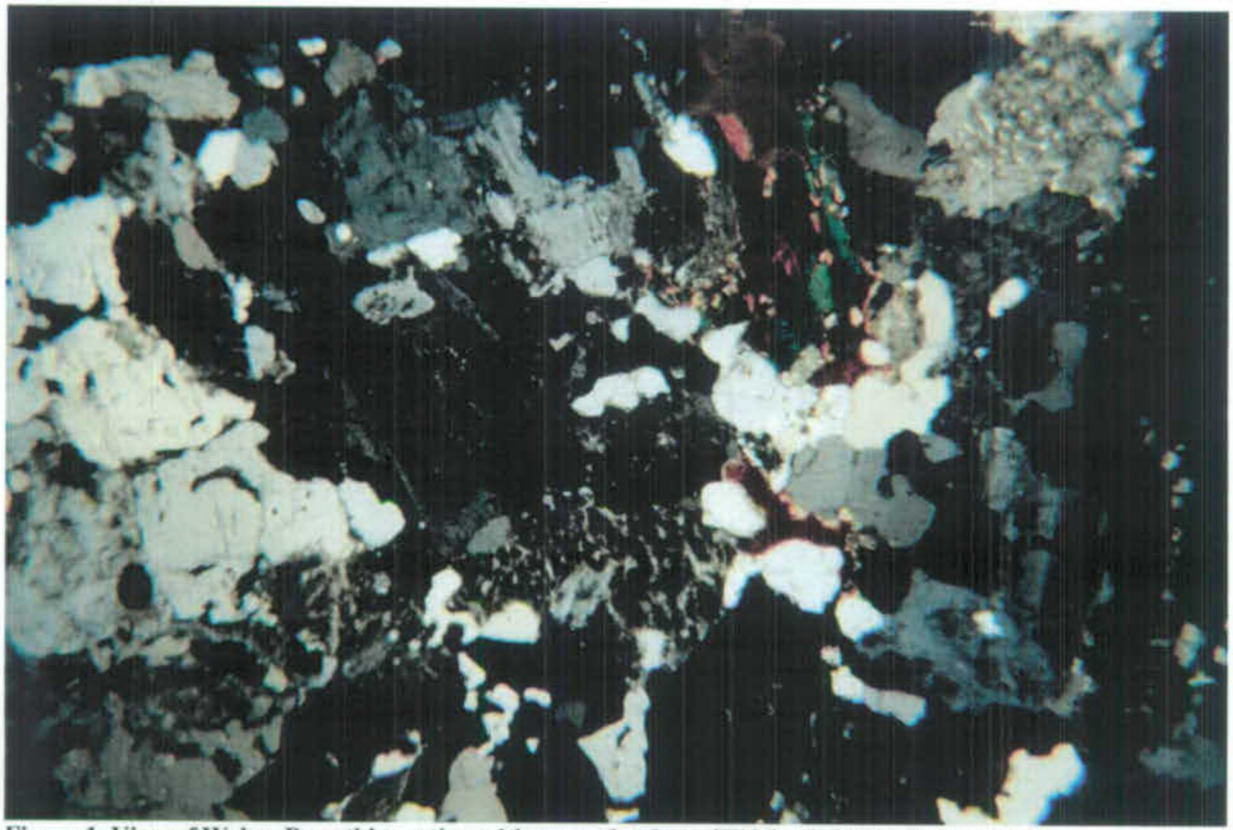

Figure 1 View of Weber Dam thin section with crossed polars. Width of view is about 5 mm.

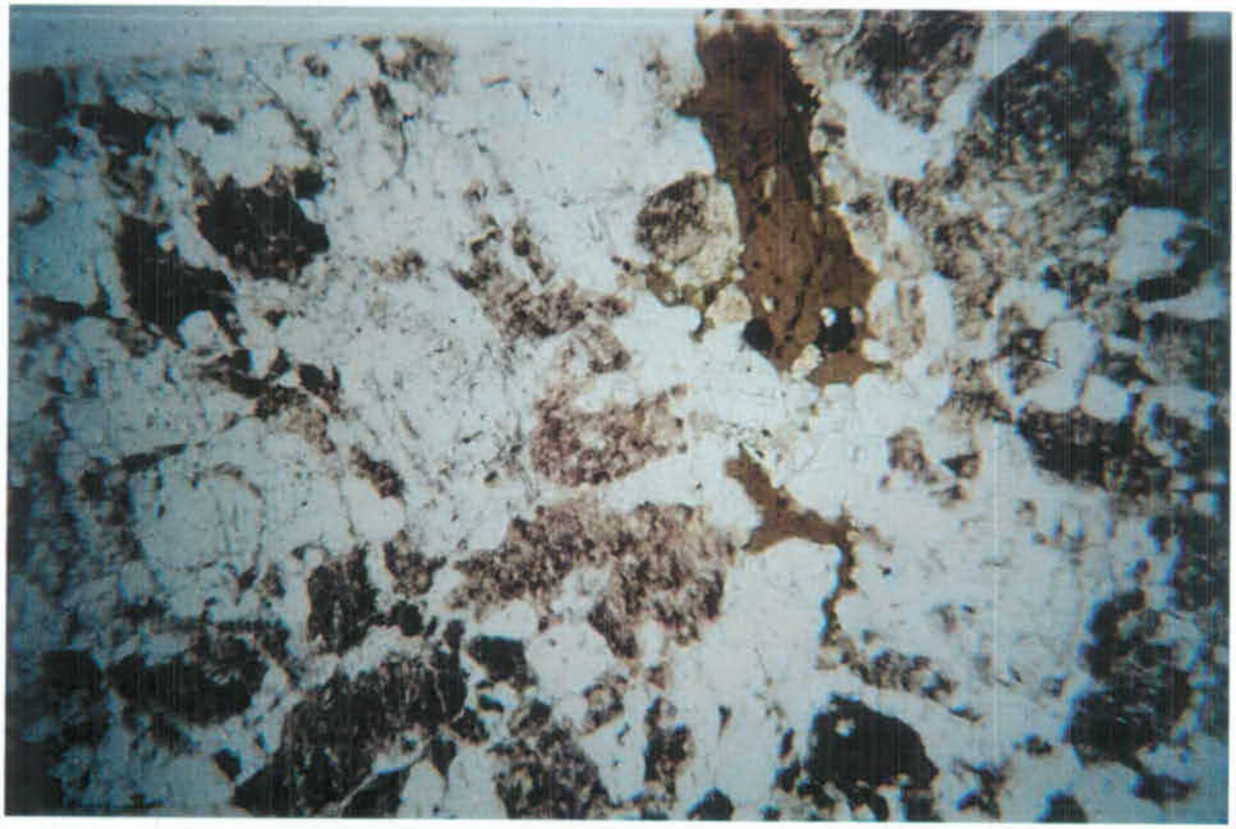

Figure 2 Same view as above with plane polarized light.

APPENDIX D

DEFINITIONS FOR QUARRY RATING CRITERIA

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Definitions for Quarry Rating Criteria

Rock Quality – The durability and soundness of the outcropping rock, as expressed by a combination of its field hardness (rock hammer test and Schmidt hammer test) and laboratory testing (Durability by L.A. Abrasion test and Sulfate Soundness test, specific gravity and point load test)

5 – Very sound rock with high field tests and higher than standards set by American Railway Engineering and Maintenance-of-Way Association (AREMA) for lab test values
4 – Moderately sound rock with good field tests and suitable lab test values, compared to AREMA standards
3 – Moderately sound rock with disparate values of field and lab values
2 – Low field hardness values and lower than acceptable (by AREMA standards) laboratory test values
1 – Very low field hardness and laboratory test values

Rock Tonnage Potential – Potential of site to produce a suitable tonnage of rock ballast, including natural deleterious zones such as weak, weathered, highly vesicular, and fractured zones and processing losses.

5 – greater than 6 million tons
4 – less than 6 million, but more than 3 million tons
3 – less than 3 million, but more than 1 million tons
2 – less than 1 million, but more than 0.5 million tons
1 – less than 500,000 tons

Mining Encumbrances – Restrictions on the proposed quarry site by mining claims
5 – No mining claims on or adjacent to the proposed site
3 – Mining claims on adjacent or adjoining properties that could impact the operation of the quarry
1 – Existing mining claim that would prohibit the development of a quarry

Appurtenant Structure Space – Adequate space near the quarry site for spoils, processing plant, living quarters, and offices.

5 – Abundant space for the support facilities adjacent to the quarry and with minimal grading required

4 – Adequate space for the support facilities, but the site is more than 1 mile from the quarry or requires a moderate amount of grading (cut and/or fill) to make the site suitable
3 – Adequate space for the support facilities, but the site is more than 5 miles from the quarry or requires a significant amount of grading to make the site suitable
2 – Marginal space for the support facilities
1 – Less than suitable space for the support facilities within 5 miles of the site.

Overburden Removal – The removal of soil, weathered rock or other unsuitable materials from the surface of the quarry site prior to production.

5 – 0 to 5 feet of overburden
4 – 5 to 10 feet of overburden
3 – 10 to 20 feet of overburden
2 – 20 to 40 feet of overburden
1 – greater than 40 feet of overburden

Length of Access Road to Highway – The length of a new access road from the quarry site/processing plant to a well-traveled, packed dirt road.

5 – less than ¼ mile
4 – more than ¼, but less than 1 mile
3 – more than 1, but less than 5 miles
2 – more than 5, but less than 20 miles
1 – more than 20 miles

Length of Access Road to Proposed Railroad Alignment – The length of a new access road from the quarry site/processing plant to the alignment of the proposed railroad alignment.
5 – less than ¼ mile
4 – more than ¼, but less than 1 mile
3 – more than 1, but less than 5 miles
2 – more than 5, but less than 20 miles
1 – more than 20 miles

Potential for Inundation or Other Harmful Phenomena – The potential for natural phenomena/processes, such as alluvial flooding or proximity to sensitive area, to negatively impact the quarry or appurtenant structures

5 – No perceived potential impacts to project components
4 – Minor potential impacts to quarry site or appurtenant structures
3 – Appurtenant structures in jeopardy of periodic damage
2 – Quarry site in jeopardy of periodic damage
1 – Quarry site and appurtenant structures in jeopardy of periodic damage

Ease of Exploration – Relative ease of access to exploratory drilling sites by drill rig for evaluation of the quarry site.

5 – Paved or existing packed dirt road within ¼ mile of the drilling locations and favorable terrain between road and drill sites
4 – Paved or existing packed dirt road within ¼ mile of the drilling locations, but difficult terrain between road and drill sites that would require grading (cut-and-fill)
3 – Paved or existing packed dirt road within 2 miles of the drilling locations
2 – Paved or existing packed dirt road more than 2 miles from the drilling locations
1 – Helicopter access only

APPENDIX E

SHANNON & WILSON, INC.
FIELD REFERENCE – ROCK CLASSIFICATION

ORDER OF CLASSIFICATION TERMS

1. ROCK NAME; (see back of sheet)
2. strength,
3. basic rock description;
4. structure;
5. weathering;
6. other or unique features
7. (Formation or Member name)

EXAMPLE

BASALT: moderate strength, gray, fine grained; moderately vesicular, smooth, closely-spaced, high angle joints with iron-oxide staining; slightly weathered (Wanapum Basalt).

FIELD REFERENCE ROCK CLASSIFICATION

3. BASIC ROCK DESCRIPTION

COLOR

TEXTURE (see back side of sheet)

CEMENTATION: Weakly / Strongly

INDURATION: Slightly / Highly

4. STRUCTURE

a) FABRIC: Bedding, foliation, etc.; Describe type, spacing, orientation

b) VESICULARITY: Describe percent by volume and size of holes (range and typical)

c) DISCONTINUITIES: Describe type, number of sets, spacing or intercept (range and typical), roughness, healing, aperture (width), filling type and consistency (use soil terms), and orientation or dip (low / high or angle)

4a. FABRIC TERMS

Sedimentary Rocks:

MASSIVE - Rock without significant structure

BEDDED - Regular layering from sedimentation

FISSILE - Tendency to break along laminations

Metamorphic Rocks:

FOLIATED - Parallel arrangement or distribution of minerals

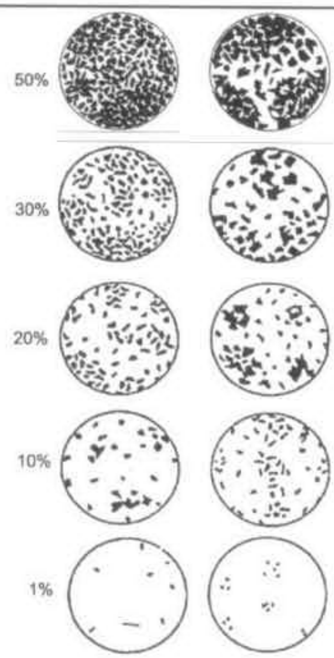
SCHISTOSE - Parallel arrangement of tabular minerals giving a planar fissility

GNEISSOSE - Segregation of minerals into bands

CLEAVAGE - Tendancy to split along secondary, planar textures or structures

4b. VESICULARITY

Slightly Vesicular	1 to 10%
Moderately Vesicular	10 to 30%
Highly Vesicular	30 to 50%
Scoriaceous	>50%



COMPARISON CHART
(percent by volume)

4c. DISCONTINUITY TERMS

FRACTURE - Collective term for any natural break excluding shears, shear zones, and faults

JOINT (JT) - Planar break with little or no displacement

FOLIATION JOINT (FJ) or BEDDING JOINT (BJ) - Joint along foliation or bedding

INCIPIENT JOINT (IJ) or INCIPIENT FRACTURE (IF) - Joint or fracture not evident until wetted and dried; breaks along existing surface

RANDOM FRACTURE (RF) - Natural, very irregular fracture that does not belong to a set

BEDDING PLANE SEPARATION or PARTING - A separation along bedding after extraction from stress relief or slaking

FRACTURE ZONE (FZ) - Planar zone of broken rock without gouge

MECHANICAL BREAK (MB) - Breaks due to drilling or handling; drilling break (DB), hammer break (HB).

SHEAR (SH) - Surface of differential movement evident by presence of slickensides, striations, or polishing

SHEAR ZONE (SZ) - Zone of gouge and rock fragments bounded by planar shear surfaces

FAULT (FT) - Shear zone of significant extent; differentiation from shear may be site-specific

4c. OUTCROP DATA

When collecting outcrop data, fracture orientation, aperture, roughness, and filling type / consistency, should be described in greater detail than is possible with core. Depending on the nature or investigation, additional data should also be recorded:

Fracture WALL STRENGTH

Fracture CONTINUITY OR LENGTH

Fracture ENDS OBSERVED (0, 1, 2)

Fracture MOISTURE CONDITIONS (dry, dry but stained, damp, wet, dripping, flowing)

BLOCK SIZE

When this level of detail is required, a special data collection form should be used.